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THE USE OF X-RAYS IN THE STUDY OF PHYSIOLOGY

By WALTER J. MEEK, Ph.D., Department of Physiology, University of Wisconsin Medical School, MADISON, WISCONSIN

ADVANCES in many lines of science are dependent on the discovery and application of some new method. Roentgen's great contribution was not three years old before Cannon was successfully using the X-ray in studying the motor mechanism of the alimentary canal. Notwithstanding this early start the use of the X-ray in physiology has been rather limited. It has enabled us to see the movements of the alimentary canal and it has given some conflicting data on the size of the heart after exercise. With these exceptions, until very recent years, there has been but little physiological application of the roentgen ray. There are now fortunately signs that this method may begin to serve the physiologist quite as well as it has the clinician, the pathologist, and the anatomist. Each advance in a related science challenges the physiologist to new endeavors. Outlining the gall bladder with tetraiodophenolphthalein and the lung structures with iodized oil, suggest new methods of approach to old refractory problems.

As a method in teaching physiology the X-ray has a value which though commonly overlooked should not be forgotten. Operation and dissection after anesthesia often succeed in showing us what the body *can* do, but sometimes entirely irrespective, I fear, of what the body *does* do under normal conditions. With the X-ray we may occasionally see things as they are. The movements of the living heart, the excursions of the diaphragm, the emptying time of the stomach and the meal's time of passage along the alimentary canal are all physiological processes of importance that may be taught the student by means of the X-ray. A well-equipped physiological laboratory must always contain a fluoroscope and X-ray apparatus.

For a number of years it has seemed to the workers in the physiological department of the University of Wisconsin that many problems of the circulation might be advanced if not actually solved by means of the X-ray. The use of this method in physiology cannot be discussed in any better way than by giving you the results of certain of these researches. The present writer is glad to accord credit for much of this work to Dr. Eyster and Dr. Hodges, with whom he has been associated.

THE HEART'S REACTION TO HEMORRHAGE (1)

Many of the reactions to hemorrhage have long been known. Body fluids enter the circulation, the vasoconstrictors act to keep up blood pressure, the larger arteries passively accommodate themselves to decreased blood volume, and a faster respiratory rate aids the venous return. Obviously,

[1]Read before the Radiological Society of North America, at Atlantic City, May, 1925.

sooner or later the heart must fail to be filled by venous blood and at that moment the output per beat must decrease. The X-ray offers a means of finding the point at which this condition is reached. If dogs under a general or local anesthetic be bled 20 to 75 c.c. at a time and X-ray films be taken before and after each hemorrhage, it will be found that no change in heart size takes place until blood equaling on an average 2 per cent of the body weight is lost. At this point there is a sudden decrease in the silhouette area of the heart shadow. There can be no doubt that the output per beat has suddenly fallen. This conclusion is justified by acute experiments with an open chest and a plethysmograph on the heart. The X-ray, however, shows that in the intact animal much more, namely, about 20 per cent, of the total blood volume can be lost before the heart reacts.

The advantage of retaining the normal diastolic size of the heart even after hemorrhage is obvious in the light of Starling's "Law of the Heart," but the mechanism that insures a sufficient venous return is not so evident. Our attention was finally directed to the capillaries and venules by the work of Krogh (2) and Hooker (3), and on investigation we found a marked constriction of these organs when the hemorrhage reached about 2 per cent of the body weight. In this way, after hemorrhage, blood stagnating in certain of the capillaries and venules was being gradually forced in to keep up the effective circulation.

More recently Eyster and Middleton (4) have extended these studies to man, taking advantage of donors in transfusion procedures. Hemorrhages in man in amounts not exceeding 1 per cent of the body weight were found to result in only transitory alterations of diastolic heart size, as determined by the X-ray. The same compensatory mechanism that we have just described was also doubtless present in these cases. One point of practical interest seems justified from all of these experiments. In attempting to relieve the heart in a case of dilatation and high venous pressure a larger amount of blood must be drawn than is usually believed necessary. The reserve in the capillaries and venules must be pretty well used up before the heart can be relieved.

THE EFFECT OF PLETHORA ON THE DIASTOLIC SIZE OF THE HEART (5)

Having found that the heart retains its diastolic size until bleeding equals 2 per cent of the body weight, it was natural to study by the same methods the results of injection, or plethora. Six per cent acacia was used for perfusion into the jugular vein of dogs. In no case did the heart area show a permanent increase in proportion to the amounts injected. Even doubling the blood volume did not increase the diastolic heart area. The excess fluid was evidently rapidly taken care of without any dilatation of the heart. There was no edema, so we again examined the capillaries and venules and found that there, indeed, were the storage organs.

Attempts to produce cardiac hypertrophy by injections of excess fluid in the hope of dilating the heart have always proved negative. It is apparent from the above experiments that the heart would not be affected unless the injections became very great indeed. The X-ray shows that the usual amount of bleeding, about 2 per cent of body weight, is still effective in reducing the area of the cardiac silhouette even after plethora.

THE RELATION OF VENOUS PRESSURE AND PULSE RATE TO CARDIAC SIZE AND OUTPUT

On these classic problems X-ray methods have also been found to be useful. While

all physiologists have agreed on the importance of venous pressure in filling the heart, the exact influence of this factor has been a matter of much debate. Some have insisted that the heart had its contents increased proportionately to the venous pressure, thereby increasing its stroke output, while others have thought the maximal capacity of the heart was soon reached and augmentation of minute output could be brought about only by accelerating the heart rate. The X-ray shows that in the intact animal both these mechanisms are in use. If the venous pressure be raised from 0 to 150 mm. of H_2O in an animal by the injection of an acacia solution and X-ray films be taken immediately, during the period that the pressure is maintained, there will be found to be a gradual increase in the silhouette areas. Above 150 mm. pressure no further increase is seen. The diastolic size of the heart is then undoubtedly largely determined by venous pressure. This does not prove, however, that the output is increased, for the systole might not have been as complete as previously.

To settle this point we have taken instantaneous exposures of the heart at the beginning and end of systole, during those periods in which the heart is a closed chamber. Bardeen (6) and Skavlem (7) have shown that the silhouette areas of the heart may be translated into volume with not more than a 10 per cent error. In the dog, the heart fortunately lies well above the diaphragm and the error is still less. In five animals we have succeeded in securing systolic and diastolic X-ray films of the heart during variations in venous pressure. In every case the increased diastolic size was accompanied by an augmented output. It is evident then that the heart may increase its diastolic size and output through a wide range of venous pressure. This method of increasing minute output by increasing stroke is, of course, supplemented by accelerating the rate. Both mechanisms are in use constantly and at the same time.

The diastolic size of the heart in relation to the heart rate (8) is a problem not only of physiological interest but of some importance to the clinician in evaluating cardiac areas. Rate, in itself, has little or no effect on the diastolic size. Thus, in a dog, if venous pressure be kept constant the rate may vary from 60 to 210 without changing the silhouette error more than a few per cent. In the intact animal, however, the conditions are quite different. As the rate rises blood is pumped out of the venous cisterns; the venous pressure falls and the heart decreases in size. When the heart rate exceeds about 110 per minute the diastolic size is rapidly reduced. Hodges has made some observations along this line on men, in whom the heart rate was increased by the administration of atropin. Heart rates were not secured higher than 130 per minute but in four out of nine cases the silhouette area was reduced from 4 to 16 per cent. Practically only the latter figure was of real importance, but the conclusion nevertheless seems justified that the rates must be kept near normal if the measurements are to be of the greatest possible value.

EXPERIMENTS ON THE PERICARDIUM

The size which the heart reaches in diastole depends on the relaxation of the musculature, the venous inflow, and the pericardial sac. Kuno (9) believed that the pericardium was necessary for the unimpaired working of the normal heart and also that the pericardium exercised under every condition of venous inflow a certain amount of resistance to the diastolic expansion of the heart, which increased with any increase in heart volume.

That the pericardium is not absolutely necessary for normal cardiac function is

now known, since it may be cut open aseptically with perfect recovery of the animal. In man, also, there is evidence that the heart may function properly without pericardial support. Through the kindness of Dr. Medlar, of the Wisconsin General Hospital, we recently saw a pericardium with a defect on the latero-ventral aspect, two or three inches in diameter. The heart itself showed no signs of hypertrophy or damage in any way.

All this does not mean that the pericardium is of no physiological value. Under high venous pressures it prevents excessive dilatation of the heart and the resultant injuries. Evidence for this view has been secured by the X-ray. If the venous pressure in a dog is increased by injection of saline or acacia from 0 to 250 mm. of water, the heart silhouette will be found to increase in size until the pressure reaches about 100 mm. There is no further enlargement even though the pressure be raised to very great heights. If, now, the pericardium be slit and the experiment repeated, the heart shows the same enlargement at low pressures that it did normally, but it is much more dilated in the higher pressures. Such results show clearly that the pericardium does not obstruct the heart normally. It does, however, resist dilatation at high venous pressures and it is therefore a protective mechanism of importance.

Just what an acute dilatation really is becomes of interest in this connection. It is probable that the heart can dilate to the limit of the pericardium temporarily without injury. At least if this were not true the pericardium could hardly be considered a protective mechanism against too high pressures. Possibly the time that the heart can remain at this degree of dilatation is limited.

THE EFFECT OF ETHER AND CHLOROFORM ON THE DIASTOLIC HEART SIZE

It has already been mentioned that one of the factors which may determine the diastolic size of the heart is the nature of the cardiac relaxation. Any condition which would decrease the elasticity or tonicity of the cardiac musculature would result in a greater filling and a larger sized heart. The existence of tonicity in the usual sense of residual contraction, however clear the idea may be to the clinician, has been stoutly denied by many physiologists. It occurred to us that some light might be shed on this problem, as well as on the cardiac action of ether and chloroform, by means of the X-ray.

When an animal is anesthetized the silhouette area of the heart may increase, decrease, or remain the same. This is due to variations in heart rate and venous pressure which have not been controlled. If the venous pressure is now held constant by injection of saline, ether anesthesia has no effect on the heart size. The amount of ether in the circulating blood in ordinary surgical anesthesia is not sufficient to disturb the normal relaxation of the heart. This is one of the reasons that, so far as the circulation is concerned, ether remains a "safe" anesthetic.

When the same experiments are run with chloroform the results are different. The heart is weakened and a given venous pressure distends it more than it did normally. This means doubtless less tension in the musculature and the contraction is not so complete. The injurious effect of chloroform is thus apparent by means of the X-ray.

In closing, may I refer very briefly to a development in the physiological use of the roentgen ray which may mean much not only to the physiologist but to the clinician? After all is said and done, the heart remains a pump and its output is of supreme

importance for the welfare of the body. To determine this output in a quantitative way would be a most practical and desirable accomplishment. The gas methods are extremely cumbersome. May it not be possible to take instantaneous X-ray exposures of the heart during the same cycle, one at the beginning and the other at the end of systole, and by comparing the silhouette areas arrive at an estimate of the cardiac output? Although there are still difficulties to be overcome, the question can, I think, be safely answered in the affirmative. Some day not far distant it may be possible actually to test the functional capacity of the heart by means of the X-ray.

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THE TEACHING OF ROENTGENOLOGY TO UNDERGRADUATES[1]

By EDWARD S. BLAINE, M.D., F.C.R.S., CHICAGO

Associate Professor Roentgenology, Northwestern University Medical College; Roentgenologist, Wesley Memorial Hospital, National Pathological Laboratory; Consulting Roentgenologist, Cook County Hospital.

AN investigation of the situation regarding the instruction of the medical undergraduate reveals an increasing appreciation by the college authorities of the important place the X-ray plays in medicine and surgery. Until comparatively recent years the medical student was given very little X-ray instruction and in some colleges none at all. Haphazard attempts to give some information concerning the value and the rôle of the roentgen ray in diagnosis as well as in treatment have been the rule, although there are notable exceptions.

The medical student formerly obtained a somewhat disjointed idea of the X-ray phase in the diagnosis of human ailments by being shown a plate or film by the clinician (not a roentgenologist), who occasionally presented the report as received from the X-ray department but most often his own interpretation, as may have suited the occasion. In such a presentation there is nothing from the pedagogic standpoint that the student gets, on which to build an appreciation of the diagnostic significance of X-ray shadows. If he is merely shown the film with the statement that it represents the condition that the demonstrator is showing, he will not obtain the desired knowledge of shadow values in terms of pathologic variations. How much better it would be for the student to be grounded in the fundamentals on which the X-ray shadows are based, preferably presented by a practical roentgenologist with a flair for teaching and well informed in physiology, pathology, anatomy, etc. If the student has been shown the basis of X-ray shadows, how they are produced, their limitations, etc., he will get a clearer concept of the shadow values in terms of normal and pathological changes. For many years this subject has been too greatly neglected, to the disadvantage of the medical graduate.

Several of the medical colleges are now giving adequate courses in roentgenology to the undergraduates, but in others the subject is presented in a manner that leaves the student incompletely informed. In a number of colleges all the X-ray instruction given consists of a very few lectures by a professor in surgery or in medicine. In certain schools there appears to be an overstressing of technical details, such as would be entirely proper were the object the training of technicians in roentgenology. In others, one finds too much time is spent in minute study of X-ray diagnosis, a thoroughness of detail more appropriate for the post-graduate preparing himself for the specialty of roentgenology. In still other colleges there is an unbalanced course given in which the student learns nothing but the therapeutic phase of X-ray, being drilled in the various formulæ of exposure technic.

A proper course of instruction in roentgenology for the undergraduate will have the following desiderati:

1. A presentation of the physics of the X-ray, not in detail but sufficiently to give him a good idea of the whys and wherefores of what is to follow, an exposition of the fundamentals of the electrical and mechanical requisites for the production of the X-rays, and demonstrations of films, exposures, and the fluoroscope. This could properly be covered by the instructor in the physics of electro- and physiotherapy or made a part of the same course.

[1]Presented before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

2. Instruction in X-ray diagnosis so designed as to give the student an appreciation of the X-ray shadow values on film and fluoroscope in the normal and pathological tissues as applied in the various specialties in medicine and surgery.

3. Informative instruction in a general way with regard to the therapeutic values of the X-ray in the treatment of disease, superficial and deep.

4. The giving of all this instruction prior to the time that the student is to apply it in his clinical studies, that is, his senior year.

The optimum time in the medical course of four years for the beginning of the instruction in roentgenology may be debatable, but it is the writer's opinion that the diagnostic instruction should be completed prior to the senior year, while the physics, the electrical, mechanical, and technical phases should be given before the student completes the first clinical year, that is, before the end of the junior year. Thus the presentation of the diagnostic work is given throughout the third year, leaving the first half of the senior term for X-ray therapy.

The amount of time that should be allotted to the instruction in roentgenology ought to be at least one hour per week in the preliminary or technical phases for one school semester, that is, a half-year, two hours per week for one year in the diagnostic phases, and one hour per week for one semester for the therapeutic phases. In this plan a total of about one hundred teaching hours will be given, which will prove amply sufficient to properly present the subject to the undergraduate.

To provide continuity of subject presentation, the several phases of the work should be given as hereinbefore stated; namely, beginning in the second half of the sophomore for physics and technics, all of the junior or third year for the diagnostic, and the therapeutic work in the first half of the senior year so that the student shall have completed the course before his entry upon the final semester. All through the senior year the student will come in contact with the X-ray in the study of the clinical material and thus will be better able to appreciate its value and apply it more intelligently than when the instruction is all given in the senior or last year. The general practice in medical colleges to-day is to give all the X-ray instruction in the senior year, which obviously is not the proper time.

The presentation of the X-ray shadows before large classes, many of which consist of upwards of a hundred and even more, is best accomplished by projection of photographic reductions of X-rays films which portray the various shadow effects on the silver screen, enlarged sufficiently for all to see the shadow details that characterize normal and pathological lesions. To show a large group the original X-ray films is not feasible as only those students close to the viewing box would benefit and it would consume too much of the instruction period to have each student obtain a near view. The lantern slides should be selected with care and consideration for the needs of the student. Rare lesions and those of unknown or unproven pathology should be avoided as they only result in puzzling and befuddling the student. The examples should be simple and should demonstrate the points covered in the lecture. Borderline cases also should be avoided in undergraduate instruction.

The well-equipped school will, of course, have a well-ventilated class room for this part of the work, which can be properly darkened, and a projection apparatus with a good lens system. The lantern slide material also should be the property of the medical school, obtained from the clinical material in the dispensary X-ray department. However, most faculty heads of departments of roentgenology have accumulated a wealth of such material, ample for

instruction, making it unnecessary for the school to obtain its own slides, but under this arrangement a change in professorship also results in a change of the instruction material.

To recognize the abnormal roentgenologically, one must *a priori* know the X-ray appearances of the normal. Therefore, the lecturer will present to the class the shadow characteristics of the various anatomical tissues, parts, and regions of the normal, and will follow these with examples of deviations by which the several lesions demonstrable by the X-ray are detected to a greater or lesser degree of positivity. A systematic development of the subject from the simple to the more complex produces the best result, and this manner of presentation is appreciated by all earnest students of medicine.

Because of the large amount of X-ray material to be presented to the student in covering the field of X-ray diagnosis (incidentally this term is a misnomer), lectures are conveniently divided and subdivided, grouped into anatomical regions such as thorax, abdomen, head, extremities, etc., and tracts such as respiratory, digestive, urinary, etc. The exact sequence of the presentation of anatomical regions, etc., is not so important as is the introduction of the X-ray appearances of the normal of a particular part, followed by examples of the pathological.

A convenient schedule is as follows:

A. BONES AND JOINTS

1. *Normal (adult):* X-ray characteristics of cancellous, cortical, periosteal, articular, and cartilaginous structures, showing all anatomical regions from head to foot.
2. *Normal (fetus, infant, child):* A study of ossification.
3. *Congenital variations.*
4. *Pregnancy, obstetrics.*
5. *Disease:* (*a*) Lesions of diaphyses; (*b*) lesions of epiphyses; (*c*) lesions of flat bones (excepting the head); (*d*) lesions of spinal column.
6. *Traumatic lesions:* Fractures, dislocations (excepting head).
7. *Pediatric lesions.*

B. HEAD

8. *Traumatic lesions, various fractures.*
9. *Pathologic conditions:* Of cranial bones; intracranial lesions; primary and secondary evidence.
10. *Orbital cavities:* Foreign body localization.
11. *Paranasal sinuses:* Normal, pathologic.
13. *Dental lesions:* Normal, pathologic.
14. *The jaws:* Normal, pathologic.

C. RESPIRATORY TRACT

15. *Pharynx, larynx, trachea:* Normal, pathologic.
16. *Bronchi:* Pulmonary.
17. *Pulmonary:* Pleural.

D. MEDIASTINAL (EXCEPTING ESOPHAGUS) *(Cardiovascular)*

18. *Heart:* Normal, pathologic, congenital.
19. *Aorta:* Normal, pathologic, congenital.
20. *Superior mediastinum:* Normal, pathologic.
21. *Posterior mediastinum:* Normal, pathologic.

E. THE DIGESTIVE TRACT

22. *Esophagus:* Normal, pathologic.
23. *Stomach:* Normal, pathologic, congenital.
24. *Small intestine:* Intrinsic, extrinsic.
25. *Colon:* Normal, pathologic, intrinsic, extrinsic.
26. *Gall bladder:* Graham test.
27. *Pancreas.*
28. *Other abdominal lesions.*

F. URINARY TRACT

29. *Renal, ureteral and bladder:* Normal, pathologic.

30. *Renal, ureteral and bladder:* Normal, pathologic; (*a*) cystoscopic, (*b*) pyelographic.

G. THERAPY

31. *Benign lesions:* Superficial, deep.
32. *Malignant lesions:* Superficial, deep.

Instruction in roentgenoscopy (fluoroscopy) offers difficulties not presented by the demonstration of the use of the X-ray in film studies. It is a physical impossibility to present this form of work to large classes; therefore, a division into small groups (preferably not over five in each) is necessary. This permits each one in the group to obtain a satisfactory view of the screen shadows and gives him a good working knowledge of the *modus operandi* of this form of diagnostic study.

The student should be shown the mode of procedure in X-ray observations on the thorax, the appearances of the normal pulmonary fields, the heart and aorta, the movements of the diaphragm; he also should be shown a few cases of the pathological lung and cardiovascular structures. He should then be shown the procedure and technic of the study of the digestive tract with the opaque meal and a demonstration made of the normal esophagus, stomach, small and large bowel, and a barium clysma should be shown to complete this phase. Clinical material showing pathologic lesions of these several structures should follow. For the purposes of the instruction work concerned in this essay, the student need not be required to attend more than two or three such séances. All of this fluoroscopic demonstration is properly done by an assistant instructor and great care must be exercised not to over-expose any one patient. The student should be especially cautioned on the possible dangers attending such a procedure. Normals may properly be chosen from among such of the students of the group as may volunteer. Dispensary material usually is available for the pathologic cases.

Through the senior year, the student will learn the actual application of the X-ray to the clinical cases in the departments of medicine and surgery as well as the various specialties. Roentgenotherapy is covered by lectures and, for reasons previously given, the first half of the senior year is the logical time to introduce this part of the subject. The biophysical effects of different radiation qualities are taught the student, which gives him the *rationale* on which X-ray therapy is based.

The instructor will avoid, as much as possible, the giving of detailed formulæ of exposure technic, as more harm than good follows the jotting down of such data by the undergraduate. If the student is taught the therapeutic value of X-radiation in the various superficial and deep-seated lesions that have been cured or benefited by the X-rays, then the desired result will be obtained. Under proper instruction the graduate will not make the mistake, too often made in the past, of sending a patient to the roentgenologist (or even to a lay X-ray technician) with the doctor's prescription form on which is written "Give five minutes X-ray treatment to the thyroid three times a week." He will have learned that all exposure technic is to be left to the roentgenologist responsible for the X-ray therapy. The effort of the instructor should be directed toward developing in the student an appreciation of X-ray values to the degree that he will have a clear idea of what the X-ray does and what it does not do in the detecting of the lesions to which the human body is subject. It is not of importance whether the student can or cannot differentiate the X-ray shadow of ulcer and malignancy of bone or stomach, etc., but he should be shown that the skilled specialist in

roentgenology can do so and he should be taught the value of thorough and complete X-ray studies so that his patients will receive the maximum aid that roentgenology can give them. Thus equipped, he will not be satisfied with inferior, incomplete, or incompetent X-ray service for he will know how much he can demand from the roentgenologist in the diagnostic search.

The prime object of undergraduate teaching of the subject of roentgenology is not to equip the student as an X-ray specialist, but to teach him what to expect and what not to expect the X-ray to do for him and his patients when he is out in practice.

POST-GRADUATE INSTRUCTION IN ROENTGENOLOGY[1]

By PRESTON M. HICKEY, A.B., M.D., ANN ARBOR, MICHIGAN

FOR the purposes of convenience, the subject of teaching roentgenology to graduates in medicine may be discussed under three sub-headings:

1. The teaching of some of the important facts in roentgenology to general practitioners, particularly those located in small towns who wish to use the X-ray in their own practice.

2. The teaching of roentgenology to specialists who wish to employ the X-ray in their own specialty.

3. The teaching of roentgenology to those who wish to become specialists in roentgenology.

Inasmuch as the X-ray machine is destined to become as useful in general practice as is the microscope, it follows that progressive practitioners will become more and more desirous of making use of the X-ray in their general practice. In the smaller towns where the doctor must, to a certain extent, do his own surgery, it follows that he will wish to be able to examine certain of his own cases. As there have been several decisions by the courts to the effect that a doctor in treating a fracture is guilty of negligence if he does not have an X-ray examination, it follows that there should be provided the opportunity for these practitioners to learn fracture technic and interpretation. If the medical teaching centers do not provide courses for these post-graduate students, they are remiss in the realization of their duties, and the post-graduate student will be compelled to gather his information from the salesmen sent out by X-ray companies. Therefore, teaching centers should consider this problem and should provide courses adapted to the above needs. These requirements should be carefully studied and the courses should be carefully planned so as to be productive of the utmost practical good. These courses should be of an intensive type and should be subdivided so that the practitioner can, if necessary, take the work at close intervals, a plan which would not require him to absent himself from his office for too long a period. These courses should be most carefully planned so as to present in a simple form the essential points in technic and furnish certain groundwork studies in interpretation. A practitioner who has the ambition to acquire proficiency should be carefully guided in his choice of text books and current literature so that by self-study he may constantly improve himself. It must be realized that there is a sharp distinction between the aim of the general practitioner who wishes to employ the ray as an aid in his everyday work, and the graduate who wishes to become an exclusive specialist in roentgenology. If the teaching centers are not alive to these demands they are remiss in their obligations to humanity. For, after all, the highest conception of a teaching center is to render its students more useful to mankind. It might be of a very great value in the solving of this problem if educational centers could receive from our special societies in roentgenology certain definite suggestions as to what should be included in these courses, and thereby establish a desired uniformity of instruction which would prevent unwholesome competition. This aspect and this particular phase of post-graduate instruction must be met by careful study, though it may require considerable time for its solution.

The second phase of this problem, namely, the requirements of the specialist who desires to include as part of his office equipment an X-ray machine to aid him in his

[1]Read before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

everyday work, is one which does not present very many difficulties. The specialist in pulmonary diseases is daily confronted with the problem of checking up his auscultation and percussion with his roentgen findings. One may say that he should send all his cardiac and pulmonary cases to a specialist in roentgenology; however, in everyday routine this does not always work out, on account of the delay and inconvenience attendant upon such a procedure. Therefore, there will always be a certain number who will seek special training in roentgenology in order to fit themselves for the solution of their own special problems. Here the problem of technic is rather narrow and perhaps easily solved. The problems of interpretation can be more easily solved, inasmuch as the clinical findings will be constantly checking up the X-ray findings. The specialists in pulmonary disease, in rhinology, in otology, in urology, and in orthopedics will desire short courses in these respective fields. Therefore, teachers must certainly take cognizance of these demands and plan short intensive courses to meet the above requirements. In this problem, too, economy of time is important. Very often in post-graduate schools these special courses could be arranged in correlation with kindred subjects. There is here a wonderful opportunity to combine courses in special pathology with courses in roentgenology.

We will now pass to a consideration of the most important problem, namely, the training of graduates who wish to take up roentgenology as their life work. The student who wishes to take up roentgenology as a specialty should have had adequate preliminary training. He should not, as sometimes observed, have been a failure in other branches of medicine, turning to roentgenology as a path of least resistance in the earning of a livelihood. His pre-medical training should have been broad, with a judicious mixture of liberal and scientific courses; his undergraduate medical work should have been satisfactory. His mental trend should incline to the analytic and judicial. The impulsive doctor is apt to be a poor roentgenologist. His decision to enter roentgenology should not have been based on the arguments of the high-pressure salesman, anxious to win commissions from the X-ray manufacturer. On account of the breadth of the problem, because the roentgenologist must in a sense be an all-around specialist, it is evident that there must now be no restriction in regard to time. No one should consider taking up roentgenology as an exclusive specialty unless he is willing to spend at least two years in preparation. If he is not willing to spend this amount of time, he should not engage in this specialty but turn his attention to some phase of medicine where the requirements are not so exacting.

The next point which we should consider is, Where should these two years be spent? If one is to devote this amount of time to study along one particular line, he will do very well to carefully consider where the best opportunities are offered for study during this two-year period. Efficient training requires more than simply the opportunities for observation and the absorption of didactic instruction. The trained specialist is one who has performed the actual minutiæ of his work so many times that through this constant drill he has become a master of all the details of the various branches. Accordingly, the would-be roentgenologist should go to the school where he will have the opportunities for thorough didactic training and—more important—where he will also have abundant opportunities to train his hand and mind by daily practice.

No one ever learned to play the piano by watching someone else play—no one ever became a roentgenologist by simply watching a roentgenologist; all of which leads up to the conclusion that the student will do

well if he chooses a school which is connected with a large teaching hospital.

The advantages of studying roentgenology in a large teaching hospital are many. Chief among these are the opportunities for checking up the accuracy, or, rather, the correctness, of roentgenologic conclusions. The value of verifications by operative conclusions, by the laboratory findings, and by pathologic diagnoses is inestimable. There is also the opportunity of studying in a well-filled and well-indexed roentgen library the original films of selected groups of cases with established diagnoses.

The course of study in such a two-year curriculum should be carefully sub-divided and graded as in any medical course. Naturally a complete study of roentgen anatomy, with comprehensive presentations of the normal structures and the non-pathologic variations of the same, would come early. The study should begin with the fetus and extend to the developing child, with especial attention to bone architecture in the normal, and include the changes occurring in old age. Variations in the number of the sesamoids and the appearance of the supernumerary bones should receive proper attention. In the study of roentgen anatomy attention should not be confined merely to the osseous system but should include other organs of the body, such as the circulatory system, studied by opaque injections, and the body cavities which can be filled by radio-opaque media.

If the student has not had courses in electrical physics, these should be given either in the X-ray department or, preferably, in the department of physics. An idea of such a course in physics has already been given by Professor Lindsay.[2] The theory and practice of photographic development and the problems of photographic chemistry should receive proper attention. The student should be taught the use of the pinhole X-ray camera so that he can always be ready to test the focal spots of the X-ray tubes. He should be encouraged to make radiographs of specimens from the operating room and from the autopsy table so that he may acquire basic ideas of pathologic densities. He should be taught to think in terms of density and contour and to frame the conclusions which should be drawn from the same. He should become familiar with the standard positions of exposure and of variations of the same for certain particular purposes. He should be required to make, under proper supervision, all the different exposures and become familiar with the problems of immobilization and of roentgen projection in immobilized patients. These cases he should handle day after day until the procedure is thoroughly understood and the operations become almost automatic. During all this time he should be keeping a careful record of the varying factors entering into the exposure and should be required to check up carefully the results, so that he can formulate his own exposure table. He should be encouraged to make use of the calipers in every case and to note the relation between the body thickness and the voltage in order to obtain satisfactory films. The economics of a roentgen laboratory should be studied also so that when he completes his course he can establish his own cost accounting in his own laboratory. If this is not done, the student may be led to think that the cost of the films was the cost of the whole examination.

When confronted with the problems of interpretation, he should be thoroughly drilled to avoid hasty diagnoses and never to express conclusions until a careful and comprehensive study of the case has been made. He should be taught to translate his observations on radio-opacity and radiolucency into the terms of normal or pathologic probabilities.

He should be given a careful course of reading in recognized roentgen text books

[2] See page 387.

and be given an opportunity to familiarize himself with standard literature so as to acquire a respect for the pioneers of his specialty and to avoid re-discoveries. If he has not already acquired a knowledge of a modern language, he should be encouraged to take special studies so that on completion of his course he will have at least a reading knowledge of one other language than his own.

At some time during the roentgenologist's course he should have some training in public speaking. He will want to attend meetings of his special societies without being classed with those who speak but cannot be heard, who address the lantern screen instead of the audience, and whose closing words are the ones most attentively listened to.

In the department of therapy he should have a thorough drill in the approved methods of testing dosage so that he will be competent to accurately calibrate his own machines. He should learn by clinical observation the results of radiation therapy. He should be encouraged to make and follow biologic experiments so as to be familiar with cell reactions.

He should be impressed with the fact that while he has need to be a master of technic, he is not a technician; that when he is requested to examine a case he should familiarize himself with its clinical aspects sufficiently to enable him to decide what examination will be of benefit. He should be encouraged to carry on collateral reading in medicine and surgery so as to be able to discuss with other physicians the modern standpoints of disease. He should be taught to respect his attitude as a consultant and to be able to demonstrate the value and limitations of roentgen examinations in any particular case.

One may say, Where can such an Utopian education be obtained? Probably no one place can be found which will present in graduated didactic form all the desired wealth of roentgenologic knowledge. Different institutions present these opportunities in various degrees, as their facilities permit.

During this period of development when post-graduate instruction in roentgenology has not yet been standardized, one may turn to the old-time apprentice methods. There is no doubt but that the apprentice method of medical education produced many great masters. Therefore, the young student who desires to specialize in roentgenology might, after he has completed his rotating internship, very properly take a resident internship in roentgenology in some large hospital. During the present period of evolution of graduate schools, it may well be that better opportunities are afforded by the apprentice method, in a Class A hospital, than by inadequate instruction in a so-called post-graduate school. In the apprentice method, if the student is fortunate enough to be associated with an experienced roentgenologist, he will have the opportunity during his resident internship to assimilate many of the important facts and to receive a manual and mental training which will be highly desirable. Every large hospital of recognized standing should have one or more resident roentgenologists, for two purposes: first, to improve its own service to patients, and second, to function as a teaching center by graduating every two years one or more trained roentgenologists. Certainly the demands of the country for such trained specialists are very great and the facilities for obtaining such training are at the present time comparatively rare. It is, therefore, fitting that such a powerful body as this Society ask such of its members as are on the visiting staffs of large hospitals, to encourage their own hospitals to establish such residencies in roentgenology.

There is no field in medicine at the present time which offers greater opportunities

to the young man to become of use to humanity and at the same time to earn a comfortable livelihood, than does roentgenology. The country has many who are endeavoring to practise roentgenology without an adequate training, and often their diagnostic conclusions are a menace to the patient.

The pioneer work of the University of Cambridge, England, in establishing graduate courses in radiology which lead to a special diploma in radiology should be an example to our American universities. Many of the latter have been very slow to appreciate the needs of special instruction along the lines which we are discussing. In some educational centers, only such graduate students are received as will take up research work which will lead to the receiving of a Master's or a Doctor's degree. Consequently, then, no courses are given for the graduate of medicine who wishes to specialize in roentgenology. It is earnestly hoped that, as time passes, more of our American universities will follow the example of Cambridge and provide special courses of instruction in radiology, a step which will do much to raise the standards of X-ray work in this country.

Our teaching hospitals are doing a grand work in providing facilities for men and women to acquire special training in operative surgery, ophthalmology, internal medicine, practical obstetrics, radiology and many other specialties, so that specialists may go out into the world equipped with the knowledge and, most of all, the practical training which will enable them to be of striking benefit to their fellow-men.

Success in teaching roentgenology lies to a considerable extent in the ability of the teacher to inspire his students, but whether the opportunities for acquiring knowledge are few or many, the final results will depend upon the attitude of the student, upon his desire and ability to work, upon an innate determination to conquer all problems presented, and upon his possessing that inborn zeal which compels him never to be satisfied but always to remain eager for knowledge.

THE USE OF RADIOLOGY IN TEACHING ANATOMY[1]

By CHARLES R. BARDEEN, M.D., MADISON, WISCONSIN

RADIOLOGY as a method of diagnosis is essentially applied anatomy. Differences in the density of tissues revealed in the fluoroscope or radiograph have to be interpreted in terms of anatomical structure. The radiologist to be a good diagnostician must be a good anatomist. To be a good anatomist he needs to frequent the dissecting room, the operating room, and the pathological laboratory.

On the other hand, the greatest contributions to gross human anatomy made in recent years have come from radiology. Radiology has made it possible to visualize the normal relations, action, and variability of many of the organs of the body in a way not possible before Roentgen's discovery. Nothing has done more to help convert gross human anatomy from a rather dreary study into a live and active one and to correct numerous erroneous notions of topographical anatomy based on studies of cadavers. To-day a radiological outfit is a necessary adjunct of every up-to-date department of anatomy.

In a medical school there should be a close and active co-operation between the department of anatomy and that of radiology. Both will benefit from such co-operation. We have here in Milwaukee at the Medical School of Marquette University a good example of such co-operation in the building up of which Dr. C. W. Geyer, whose untimely death we all deplore, played a most active part. Furthermore, radiologists not connected with the teaching staff of a medical school will find it worth while to make frequent visits to the anatomical departments of some neighboring medical school to refresh and enlarge their knowledge of gross human anatomy. Such visits will help to stimulate the interest of the anatomists in radiology. In return for the privilege of frequenting the anatomical laboratory the radiologist may present films or copies of films which in the course of his practice he finds especially illustrative of anatomical conditions and which will help to strengthen the collections of the department of anatomy. It is, however, rather from the point of view of the medical student that I desire to speak to-day of the relation of radiology to anatomy.

For the medical student the value of the study of gross anatomy lies partly in the training offered in manual dexterity and in skill in observation and partly in the opportunity offered to learn something of the human body as a working mechanism. Dissection helps to train the hand and eye, but it does not of itself show how the body works. To think of structure in terms of function the student must compare the structures revealed in the dead body with such data as he may obtain of the form and the action of these structures in the living body. The surface anatomy of the living body is an aid in this direction, but has great limitations. Radiology offers much help. Plates and photographs, and especially stereoscopic radiographs, help the student to think of the structures found in the cadaver as in place in the living body. The fluoroscope is of even greater value in enabling the student to think of the bones and joints, the heart and lungs, the digestive tract and other structures as parts of a working mechanism. The student of anatomy should be made acquainted with the value of radiology in the study of gross human anatomy at the very beginning of the course and should continue to make use of it throughout the course. This will not make radiologists of the students but it will help them as practitioners

[1]Read before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

to make intelligent use of radiology, and if they subsequently become specialists in this field, it will give them a good background from which to start.

For those interested in the use of radiology in teaching medical students who are beginning the study of gross human anatomy, attention is called to the radiographs and photographs in the scientific exhibit. These illustrate two of the methods used. The third, the use of the fluoroscope, is, we believe, more important than either of the other two methods, but it is a method which, unlike the other two, needs careful supervision. It is the method, also, in which the anatomists especially appreciate the aid of radiologists.

In making use of radiology in the teaching of gross human anatomy a few points I think need to be emphasized:

1. Radiographic photographs and films must be conveniently arranged for study if the student is to make as much use of them as is desirable. They should be on display either in the dissecting rooms or in a study room of easy access from the dissecting rooms. The photographs may be bound in sets or arranged in sets for a wall display. It is quite important that clear legends accompany them. The films may be displayed in undarkened rooms if care is exercised in arranging display boxes. If films are displayed only in a small dark room and have to be hunted out in a file before they can be displayed, it is likely that the student will make much less use of them than he otherwise would.

2. Legends should be freely used for both photographs and films in order that the student may make use of them without the immediate aid of an instructor.

3. An instructor trained in radiology should always be present when the fluoroscope is used.

In conclusion, I desire to show a few lantern slides to illustrate a recent contribution to the topographical anatomy of young normal adults made by means of radiology in the department of anatomy of the University of California. This study has to do with variations in positions and shape of some of the abdominal viscera and with change in position and form with change in posture. The originals of the pictures shown may be found in the article by Moody, Chamberlain and Van Nuys in the *American Journal of Anatomy,* 1926, XXXVII, p. 273.

The chief points brought out by these pictures are as follows:

1. There is great individual variation in the topography of the abdominal viscera in different individuals.

2. In a given individual there is much change in the form, position, and relations of some of these viscera with change in posture from the erect to the prone position.

3. The most marked changes are in the stomach. In shifting the posture of the body from the vertical to the horizontal positions as a rule the stomach moves cranialward, the contents are massed in the cardiac portion of the stomach, the long axis of the stomach is decreased, its width increased and the pyloric end of the stomach generally shifts to the right as well as cranialward.

4. The distance through which the most caudal part of the stomach shifts with change of posture is called its excursion. This excursion varies in normal individuals from zero to 16 centimeters. The extent of excursion is not closely correlated with typical form. Long stomachs with a low greater curvature in the vertical position may have a short excursion while stomachs with a high greater curvature may have a long excursion.

5. In the vertical posture the most frequent position of the distal end of the stomach was found in a study of 300 healthy men by Moody and his co-workers to be

2.5 to 5 centimeters below the interiliac line, in 300 women from 5 to 7.5 centimeters. In a corresponding study of 250 individuals of each sex in the horizontal posture the distal end of the stomach was found to be most frequently from 2.5 to 5 centimeters above the interiliac line. Thus the distal end of the stomach in both sexes is about the same in the horizontal posture, while it is lower in women in the vertical posture.

6. The transverse colon in the healthy living adult usually loops down more between the flexures than is pictured in the anatomies. In the vertical position the distal margin was found to average 5 to 7.5 centimeters below the interiliac line in men, 10 to 12.5 centimeters below this line in women. As a rule it changes position less than the stomach with change of posture.

7. The cecum in over 60 per cent of individuals of both sexes was found to be in the pelvic fossa when the posture of the body was vertical.

8. The distal margin of the liver was found in the vertical posture to be below the interiliac line in 52.3 per cent of women and 41.2 per cent of men. In change of posture the distal margin of the liver showed an excursion which varied from zero to 9 centimeters.

9. The relative position of the duodenum and head of the pancreas was found in most instances to differ markedly from that of the classical text-book illustration of these structures.

For other details those interested are referred to the original article of the authors cited. Enough has here been given to illustrate the importance of the newer living anatomy revealed by radiology in training of the medical student.

STUDIES IN THE PHYSICS OF X-RAYS FOR STUDENTS IN MEDICINE[1]

By GEORGE A. LINDSAY, Ph.D., Ann Arbor, Michigan

THIS is without doubt the day of the specialist. Furthermore, unless there is some retrogression in the tremendous forward movement in scientific knowledge which has been under way in recent years there is every prospect that the specialist will become more and more a necessity. The term "specialist" is nowhere more common than in medical science. In fact, if the word "specialist" is used without qualification, the implication to the average person is a physician who limits his labors to a portion of the field, in which he is accordingly supposed to be particularly an authority. Owing to the exigencies of modern life it too often happens that specialization in one particular line is accompanied by considerable neglect and ignorance of nearly all other lines. This has become a misfortune attendant on the modern system of specialization, whether in medicine or in any other branch of knowledge.

The field of the radiologist is yet too new to be precisely defined. New phases of his work are constantly developing and phases now unknown are quite certain to appear and demand a place. The one who can develop these new phases most successfully is the radiologist himself, provided he is properly equipped. There seems to be growing a conviction that those preparing to become radiologists should have as much training as possible in the fundamental physical principles underlying the working of the apparatus they are called upon to use, and in an understanding of the nature and the significance of X-ray phenomena. It is in response to such a demand that the work now briefly to be sketched has been organized, and is at present being offered at the University of Michigan. It has been encouraged especially by the Department of Roentgenology at the University Hospital and is given jointly by that Department and by the Department of Physics.

One meeting per week consists of a lecture or discussion of the underlying theories and one 2- or 3-hour period is devoted to experimental work. I shall confine myself mostly to a description of the experimental side. The theoretical work is in quality and quantity represented by such a book as Kaye's "X-rays," supplemented by material which may be inferred from the nature of the experiments. For the sake of definiteness I shall number the experiments as I describe them, though it is to be understood that the course is flexible and that the experiments may be changed or modified as desired.

Experiment No. 1. Pressure in a Simple Discharge Tube

A simple discharge tube with cold cathode is evacuated and a discharge is sent through it, preferably from a uni-directional source. The pressure is measured by a McLeod gauge and the appearance of the discharge is noted at various stages. When the pressure is so low that the discharge no longer passes, the student finds by calculation that there are still of the order of 10^{13} molecules per c.c. in the tube, or, if the molecules were in rows and evenly spaced, about 3,000 of them would be encountered in going 1 mm.

Experiment No. 2. The Measurement of High Voltage

The high voltage from a transformer is measured in several different ways: (*a*) by

[1]Read before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

the auxiliary coil in the transformer itself; (*b*) by an electrostatic voltmeter; (*c*) by a spark gap.

The first two instruments give effective values of the voltage; the spark gap indicates the peak voltage. The comparison introduces the ideas of wave form and of the relation of peak voltage to effective voltage. Spheres of various sizes may be used, also points and planes. The experiment may be either a calibration of the spark gap in terms of the other voltmeters, or simply a comparison of the several instruments. Usually they agree none too well.

Experiment No. 3. The Characteristics of Gas-filled Tubes

Although of course these tubes are practically out of use in professional work they do teach certain ideas about the conduction of currents in gases, which cannot be learned from the modern electron tube. A good understanding of the properties of the electron, which is perhaps the most important fundamental unit with which we are acquainted in the material universe, cannot be obtained merely by driving electrons through a highly evacuated space such as we have in the Coolidge tube. The voltage on the tube is varied from a value so low that the discharge will not pass, up to the capacity of the tube, and the characteristic curves of voltage and current are plotted for several tubes of various degrees of hardness.

Experiment No. 4. Characteristics of the Coolidge Tube

The current voltage curve is plotted for this tube and compared with that for the gas-filled tube. The curve between filament current and tube current at constant voltage is also obtained. The excellent control of the Coolidge tube is thus demonstrated. It is also convenient here to study the kenotron as a rectifier of high tension alternating current.

Experiment No. 5. Factors Affecting the Output of the Coolidge X-ray Tube

The intensity of the X-ray beam is measured by an ionization chamber and an electroscope. These instruments require some study in order that the student may become familiar with the principles on which their operation depends.

Leaving the ionization chamber fixed at a convenient distance from the X-ray tube, the current through the tube is varied while the voltage is kept constant. The rate of fall of the electroscope leaf is taken as the measure of the intensity of the X-ray beam. The results show that the intensity varies as the current and as the square of the voltage. An idea of the corrections necessary for the complete measurement of the X-ray energy may be suggested by observing that for low voltages, although a current is passing through the X-ray tube, no X-rays are transmitted through the walls.

Experiment No. 6. Comparison of X-ray Apparatus for Treatment Purposes

By using the same electroscope the output of different tubes actuated by the same or by different apparatus may be compared. It is not safe to assume that if current and voltage are the same, the X-ray beam will produce the same effects for all apparatus.

Experiment No. 7. Relation between Physical and Biological Dose

The quantity of X-ray radiation which will produce a certain erythema is determined by measuring with the ionization chamber and electroscope the intensity of the X-ray beam employed.

Experiment No. 8. Coefficient of Absorption of X-rays

The study of absorption is given considerable emphasis, because the absorption or transmission of X-rays is the all-important question in their application in medical work.

The equation $I = I_0 e^{-\mu x}$ does not give the student much sense of the significance of the absorption coefficient μ. Although he may not be familiar with the notation and methods of the calculus, yet it has been found that *dI* may without much difficulty be comprehended as a small change in intensity due to absorption and scattering in the small distance *dx*, and if *I* is the intensity of the X-ray beam, then

$$\mu = -\frac{dI}{I} \cdot \frac{1}{dx}$$

means the per cent of energy of the X-rays which is lost per unit distance. Either of the above equations may be put into the form $\mu = \frac{\log I_0 - \log I}{x}$ which after changing to the common system of logarithms gives μ.

μ is measured for various thicknesses of some substance such as copper or aluminum placed in the path of the beam, and it is shown that as the strips become thicker the measured coefficient becomes smaller. This is due to the fact that the softer X-rays are absorbed first and they have a larger coefficient of absorption. Mass coefficients and atomic coefficients are also calculated.

Experiment No. 9. Absorption Coefficients in Different Substances

Absorption coefficients of such elements as Al, Fe, Cu, Zn, Ag, Cd, Sn, Pb are determined, using the same quality of radiation. The mass coefficient shows an increase with atomic number of the element used as absorber. It is noted, however, that a curve plotted between mass coefficient and atomic number does not rise continuously, but in general it will appear that at some point a heavier element has a smaller absorption coefficient than the elements just below it. This shows the now well-known phenomenon of selective absorption.

Experiment No. 10. Control of Depth Dose by Iontoquantimeter

The intensity of the X-ray beam is measured at various positions in a tank of water. The action of the water in absorbing and scattering X-rays is approximately the same as that of body tissue.

Experiment No. 11. The Continuous Spectrum from an X-ray Tube

The study of spectra has been such a fruitful source of knowledge in recent years, that no one can be said to have even a moderate understanding of the subject of X-rays unless he is somewhat familiar with the fundamentals of X-ray spectroscopy. The properties of X-rays in general are very markedly a function of the wave length. Thus, the absorption coefficient, for example, is increased by a factor of about 8 when the wave length is doubled. As in the spectra of visible light we have in X-rays emission spectra and absorption spectra. In emission spectra we have the continuous spectrum and the characteristic spectrum. We consider here the continuous spectrum.

Every substance used as anticathode, while being bombarded by electrons from the filament, emits X-rays of all wave lengths from a lower limit, which can be calculated from the voltage applied to the tube, up to the longest waves which can be detected. At a certain wave length the energy is a maximum. By producing a spectrum after the well-known Bragg method, the student may, by making various settings of the

ionization chamber and crystal, construct as much of the intensity wave length curve as time will permit, and find at what wave length the maximum occurs.

Experiment No. 12. Accurate Measurement of Wave Length

With the equipment at our disposal it is most convenient to measure wave lengths of lines in the characteristic spectrum by means of the vacuum spectrograph designed by Professor Manne Siegbahn, of Upsala, Sweden. Space does not here permit a description of this instrument. A full account may be found in Professor Siegbahn's book on "The Spectroscopy of X-rays." The spectrograph is particularly well adapted to long wave lengths, say from 0.5 Å. up as far as the spectrum has been extended by crystal reflection.

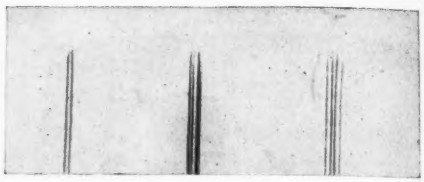
The accurate measurement is made as follows: The line whose wave length is desired is photographed on the same plate on both sides of the zero position by turning the crystal so as to reflect the beam first on one side and then on the other. The plate settings are made so that the two positions of the line fall only a few millimeters apart on the plate. By measuring the distance by which they are separated, and by reading the angle through which the plate holder has been turned, the angle of reflection θ may be found accurately. Substitution in the formula $\lambda = 2\ d \sin \theta$ gives the wave length. λ is the wave length, d is the grating constant of the crystal used, and θ is the grazing angle of reflection from the crystal.

Experiment No. 13. Spectra of Higher Orders

The above formula for λ is for the first order of spectra. For higher orders

$$\lambda = \frac{2\ d \sin \theta_n}{n}$$

where n is the order of the spectrum. Thus the second order of any given line appears at an angle θ_2 such that $\sin \theta_2 = 2 \sin \theta_1$: for the third order $\sin \theta_3 = 3 \sin \theta_1$. Figure 1 shows the first, second, and third orders of the lines known as $K\alpha_1$ and $K\alpha_2$ in the spectrum of copper. They were taken by reflection from a crystal of anhydrite. It will be noticed that the lines α_1 and α_2 are separated more the higher the order of the spectrum.



a *b* *c*

Fig. 1. Double photographs of the Copper $K\alpha_1$ and $K\alpha_2$ lines in (*a*) the first, (*b*) the second, (*c*) the third order.

Experiment No. 14. Determination of the Grating Constant d

The Bragg formula $\lambda = 2\ d \sin \theta$ may be used equally well to determine d if λ and θ are known. The experimental method is the same as in the preceding experiment for finding the wave length.

Experiment No. 15. Absorption Limits

It has been stated above that elements manifest a preferential absorption for a certain wave length of X-ray radiation. This abnormal absorption may be shown very beautifully by photography. The photographs require much longer exposure than the emission lines, for the phenomenon is absorption in the continuous spectrum, and the continuous spectrum is very faint, compared with the strong lines of the characteristic spectrum.

The absorption limits may be obtained by placing a thin screen of the absorbing substance in the path of the beam and setting the crystal and plate at the proper angle to obtain that portion of the spectrum in which

the absorption edge occurs. Figure 2 shows two such edges rather near together due to absorption in barium. Since absorption as

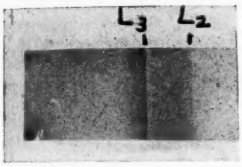


Fig. 2. The L_3 and L_2 absorption edges in the X-ray spectrum of barium.

well as emission is primarily an atomic phenomenon, it makes very little difference whether the element being investigated is in a chemical compound or not. The theory of these absorption edges leads to a knowledge of the structure of the atom, and of the work necessary to ionize the atom by removing electrons from it through the medium of absorbed radiation.

These are some of the experiments which may be done without great difficulty, once the equipment is provided. The apparatus is necessarily so complicated and expensive that for the most part only one small group of students—perhaps five or six—can work advantageously at one time. If desired, the work could profitably be extended to cover a much longer course.

DISCUSSION

DR. ADOLPH HARTUNG (Chicago): In regard to the undergraduate teaching of roentgenology, there is a tendency at the present time to bring some of the practical aspects of the work to the medical student during the earlier years of his studies, and for that reason I think it is a very good plan to provide the teaching in a way which has been indicated by some of the speakers —*i.e.*, to give some attention to anatomy and physiology from the roentgen standpoint when those subjects are being taught. These speakers have taken up only a small phase of that work, as it can be taught; for instance, in anatomy, the roentgenologist can, by working with the anatomist, give a great deal of information relative to the anatomical development of the bony skeleton and give it in such a way that his subsequent teaching of the subject will be very much clearer to the student. The same is true in physiology: he can teach the method of deglutition, the peristaltic movements of the stomach and bowels and the respiratory and cardiac movements, and in that way lead on to the ultimate teaching of his particular subject. I think these phases of roentgenology might advantageously be combined with the teaching of other branches, rather than to wait and take up the entire subject in consecutive periods, as Dr. Blaine has indicated.

DR. SETH HIRSCH (New York): The post-graduate teacher is fulfilling a very important function. He is confronted by a generation of men who have not had the advantages of graduate teaching in roentgenology, and who feel the need of such knowledge in their particular work. But, after all, the present practitioners are of a generation that is passing and the present teachers of roentgenology to post-graduates are meeting only a temporary problem. But what of the future? How shall roentgenology be taught and what are the prospects of roentgenology remaining a specialty?

Since roentgenology enters into almost every aspect of diagnosis and radiation therapy plays an extremely important rôle in our therapeutics, it is important that roentgenology be taught as an integral part of the medical course and more deeply and extensively than it is being taught to-day. It always has seemed to me that roentgenology should be taught to the student in medicine according to the method advocated by some of the speakers this afternoon. But

the roentgenologic essentials of any particular specialty in medicine, let us say the chest diseases, can be taught by one who is teaching the clinical aspects of these diseases only when the fundamentals have already been inculcated. By this I mean that the roentgenologic aspects of anatomy should have already been taught by the anatomist and the physiologist; the roentgen physiology should have already been impressed upon the student's mind, and the gross pathologist should have taught the roentgen appearance of the gross pathologic lesions. This is being done in some schools. Gross pathologists are more and more directing attention to the roentgen appearance of the gross pathologic lesion as part of their studies. The student will then have a fundamental knowledge and an approach to the appreciation of the various radiological phases of the problems as he meets them in clinical study. The time will come when the practitioner will have been so educated in radiology that he will study his cases as does a thoroughly trained roentgenologist. The roentgenologist will then pass out of existence as a specialist, and be a *rara avis,* as the microscopist is to-day.

Dr. LeWald (New York): I would like to take exception to one statement of Dr. Blaine, in which he states that the undergraduate is to be taught fundamentals only and should not be befuddled by having anything about the unusual cases told him. Now I do not agree to that at all. Dr. Hickey spoke of having the medical man study some other language than his own. I am sure that when Dr. Hickey took up French he was taught within a few days that there were many irregular verbs and many idioms, and if he had not known and used those he would have been a very poor French scholar. I appreciate Dr. Blaine's intention—that the course, as ordinarily laid out, is not long enough to take up every possible variation, but I know several instances where it would well apply. For example, in anatomy. Take the subject of *transposition,* which is not so rare as we used to think. A student at a university of which I know was dissecting the vessels in the neck, and he told the instructor in anatomy that the text-book was wrong. The instructor corrected him by opening the thorax and showing him that it was a case of transposition and that the innominate vein, as well as the other structures in the neck, was transposed. Somewhere in his course in anatomy the student should have been instructed that he might at any time encounter such a case. To follow that same case along a similar line of thought, a doctor said that he had a patient with transposition of the viscera, on physical examination, but that he had had an X-ray examination made and it had been reported that the heart was where it should be, on the left side. I asked him if he would produce the film and the child, and he did both. The film was a double-coated film and had no marks upon it to distinguish the right from the left side, and the mistake was made in that way. *I believe the medical student should be taught to recognize every anomaly known.*

Dr. Blaine (closing): I agree with the discussant who predicts the future of X-ray practice in the coming generation, when physicians all will be X-ray experts and thus will not need us as roentgenologists to do the part that we are doing nowadays, but I am thinking more in the terms of what we have to contend with right now, rather than what the situation will be in the future. That may be a very desirable thing, as Dr. Hirsch has said. Answering Dr. LeWald, please note that I did not read all of the detailed subdivisions of the subject that I believe should be presented to the undergraduate student, which will appear in my

paper as printed; congenital variations are an important part of X-ray teaching and one of the things to be considered, as the outline will show. I know he, as well as many others experienced in X-ray instruction work, can think of some particular item that my presentation does not cover specifically. I am trying to present a main idea to the undergraduate, rather than aiming to cover every possible condition that can be demonstrated by the X-ray. Viewed from certain angles, it would be very desirable to have all doctors fully competent to correctly read any X-ray films, as Dr. Hirsch has said; but this will not be regarded as practical by many who are intimately acquainted with the rank and file of the medical profession to-day. Dr. LeWald's remarks led me to explain that I purposely left out of the reading of this paper the cataloging of the subjects which I regard as proper material for undergraduate instruction; congenital variations form an important division in the teaching of roentgenology. The crux of the matter to me appears to be this: that the subject should be taught not too briefly, thus leaving a vague impression of the place of X-ray in medicine, nor too extended in detail, unsuited to the needs of the average physician-graduate. It is neither necessary nor desirable that the undergraduate be made a finished roentgenologist any more than that the faculty in surgery point him to graduating as a finished surgeon. If, in the future, all physicians and surgeons are to be expert in X-ray interpretation, as prophesied by Dr. Hirsch, an event which I do not foresee, then, of course, we, as roentgenologists, will have no call for our services. My essay is designed to meet a situation in medical teaching that now exists, not to cover so radical a change in the medical field as he predicts.

DR. HICKEY (closing): *Apropos* of the remarks of Dr. Bardeen, I might say a word as to what we are doing at the University of Michigan. Dr. Carl Huber, the professor of anatomy, and the speaker maintain a very close working relationship between the anatomy department and the department of roentgenology. During the latter part of the Freshman year, when the student has acquired some knowledge of anatomy, Dr. Huber invites us to deliver as many lectures as we desire, taking up the subject of anatomy from the X-ray standpoint. In the talks which I give, I do not talk about X-ray work, but I talk about anatomy as it is illuminated by the X-ray. In the dissecting room Dr. Huber has illuminating boxes for which the X-ray Department furnishes typical films of different parts of the body which can be referred to by the students in their everyday anatomy work.

UNDERGRADUATE INSTRUCTION IN ROENTGENOLOGY

By JAMES J. CLARK, M.D., Associate Professor of Roentgenology, Medical Department Emory University; Roentgenologist Wesley Memorial Hospital, Grady Hospital, Hospital No. 48, U. S. V. B., ATLANTA, GEORGIA

THE instruction of undergraduates in roentgenology has in the past years required considerable thought and discussion. Many in the past believed that it was unnecessary, but during the last two or three years practically all of those on the negative have changed to the positive side, due to the constantly increasing use of this method of examination in the thorough study of the patient.

A physician who is devoting himself to one of the numerous specialties in medicine is apt to become a little warped in his judgment as to its importance, and as to how much of his specialty should be taught. He is inclined, perhaps, to wish to give his own department a too prominent part in the curriculum, as to him, naturally, it is the great thing in his life. Therefore, I believe the teaching of the different specialties should be open to discussion by instructors in other departments, in order that we may not allow our enthusiasm, or lack of it, to provide too much or too little instruction for the student.

I remember my own college years, recalling that all the instruction in roentgenology was confined to a couple of hours at the hospital, where the instructor demonstrated the use of the fluoroscope and showed a few films, he, unfortunately, using himself as a means of demonstrating the penetration of X-ray. To-day he suffers from a severe X-ray dermatitis of the hands.

The years since the war have shown a great increase in the number of workers in X-ray, and also a tremendous increase in the number of X-ray equipment installations in the offices of physicians for use in their own practice. As a result, an increasing number of unfortunate patients have been accidentally burned, either by unskillful treatment or by accidental over-exposure during fluoroscopy or film examination, due to a lack of proper understanding of the dangers from too much X-ray exposure. Incidentally, this has resulted in a large increase in the insurance rates for malpractice for men doing radiological work, the rates in certain instances having increased 500 per cent. We have also observed severe injury to brother physicians who have been inclined to a too promiscuous use of the fluoroscope, both in the reduction of fractures and in examinations, with the result of severe injury to their hands. The fact is that the X-ray in the hands of an unskilled man is as dangerous, or more so, than the knife in the hands of an unskillful surgeon; surgical mishaps usually heal, while X-ray burns always leave serious lesions in their wake.

All these facts lead me to believe that the medical colleges must, and will soon, be forced by circumstances to pay more and more attention to the instruction of the undergraduate in roentgenology. This instruction is deemed necessary, first, that he may appreciate and understand that a great deal of intensive study and considerable experience is necessary before one is able to comprehensively handle this agent. Secondly, that he may learn there is a great deal of danger, both electrical and from the X-rays themselves, to himself or his patients, if he is not well instructed how to avoid these mistakes. Lastly, the roentgen ray is probably our most valuable aid in the diagnosis of the obscure element in many cases, and is the only agent, except surgery, that enables us to see below the surface. Therefore, this important diagnostic branch

of medicine should, and must, be impressed on the mind of a medical student.

Granting that the subject should be included in the curriculum, we must next decide how much instruction the student is to have; how much shall be didactic, and how much clinical. The writer's own experience, which has been cited, demonstrates in his opinion the growth and demand for this type of instruction.

In 1919 I joined the staff of the Medical Department of Emory University. At that time the cases from the clinics requiring X-ray study were referred to the X-ray laboratory, which was located in the basement of the building. In spite of a large clinic of good material, the roentgenological work consisted mainly in the examination of fractures, and rarely a chest or gastric case. There was no place on the schedule for instruction of the students; no clinics were held. In spite of this small amount of work, we noticed a gradual increase in the number of students attendant upon examinations, an increasing desire to see the results of the examinations of patients in whom they were interested, and a checking of the clinical with the roentgenologic diagnosis. The next year an hour a week was added to the Junior students' course. The students were given some idea of film interpretation in simple cases. The next year this class (the Senior) requested that they be given further instruction, so that a course in clinical work and interpretation was added to their year's work. We also increased the variety and scope of work which was given the Juniors.

A second reason for the addition of this course to the Junior year was the fact that at this university the Juniors are given considerable clinical work in the out-patient department, and we wished to show and impress upon them the type of case wherein they might expect to receive help from the X-ray department in diagnosis. We had two motives in this: First, to help the student; second, to help out the laboratory, and save us the expense and work in examination of a large number of patients where there was really no reason for an X-ray examination.

Later the roentgenologic department was moved to better quarters in a more accessible location, with the result that the increase in the number of examinations exceeded all expectations, jumping each year over 100 per cent, until now, with the increasing clinical material and the addition of hospital cases, we are examining over five thousand cases a year, and the increase is not over yet.

The result has been that, year by year, due to the solicitation of the students, the increasing use of the X-ray as an aid in the examination and diagnosis of their cases, and its use in the clinics, both medical and surgical, we have been forced to put the student in a position where he can not only understand what instructors are trying to demonstrate on a film at the bedside and in clinics, but can form a pretty fair idea himself of the pathology present.

All of the above-named circumstances have resulted in our attempting to place the X-ray department where it will function to the betterment of all. We, therefore, have added each year a little more to the instruction course; we have endeavored to do all in our power to get the student, as well as the visiting man, to come to the X-ray laboratory and see his cases. We are furnishing the films to the wards, where in each case they are kept accessible to the patient's bed for use in the ward clinics, being returned to the X-ray department when the case is dismissed. While this entails considerable work, and films are occasionally lost or mislaid, we feel that it is well worth while, and it gives to the student a real insight into the case with which he is working.

The following method of instruction is now in force at the Emory University Medical Department: The students are taken as Juniors, as it is at this time they begin work on the out-patient clinic and on the wards. They receive a weekly lecture during the entire year, which is designed to cover comprehensively the subject of X-ray. This starts with the development of X-ray apparatus, including the use of electrical currents, transformers, rheostats, etc. Opportunity is afforded of examining the different apparatus in this department. The lectures progress weekly, covering the entire body, its different tracts, and the more frequent and more easily diagnosed lesions.

This class, which usually numbers around fifty, is divided into four sections. Each section has an hour a week in the clinical laboratory, where interpretation of the films is taught, care being taken that plenty of material is available to illustrate the subject covered in the past week's lecture. For example, if the chest was the subject of the last lecture, we show to the students the grosser types of tuberculosis, pleuritic effusions, hypertrophied hearts, aortic aneurysms, etc., to fix in their minds the difference which may be noted on the films. If the subject was bone pathology, a corresponding course is carried out, demonstrating to the group the usual types of osteomyelitis, syphilitic bone lesions, malignancies, arthritides, etc. Also during these hours plenty of normal films of the corresponding parts are kept on hand so that the students may definitely have impressed upon their minds where the pathological film departs from the normal. The amount of material available is such that we are able not only to cover the previous lecture, but to review weekly other types of lesions which have or have not been covered by the lectures.

This scheme of operation permits each Junior student to receive approximately thirty hours of lectures covering the subject of X-ray, and also twenty hours of clinical review of the films. We also see that considerable use is made of the fluoroscope. In addition, lantern slides are used before the entire class to demonstrate various lesions on the screen, as an aid to better understanding of screen demonstrations, both in classes and at medical meetings.

In the Senior year the students, in groups of five to seven, receive five hours clinical instruction, during which time the cases they are working up are reviewed from the X-ray standpoint.

The above method of instruction requires a great deal of time on the part of the instructor, averaging about four hours weekly during the college year, totaling about one hundred twenty hours. Additional hours are necessary to take care of the diagnostic work of this busy laboratory.

The location of the department, accessible as it is to all departments of the hospital, has resulted in a general increase in the number of students who follow their cases to this laboratory, and who in their leisure spend time reviewing interesting films.

I wish to state that we do not attempt to make specialists of these men, but to impress upon them the elementary rules of roentgen diagnosis and make them familiar with the usual appearance on the films of the more frequently encountered pathologic conditions.

Now, the question arises, Is all this instruction necessary and is it worth while? The important point to decide upon is, Has the student gained anything from this course, and will it help him in his future work?

1. The first point of interest is that he has obtained definite ideas as to the value of X-ray in diagnosis. He knows in what type of case he may expect help.

2. He is able to interpret to himself and

understand written reports of examinations previously made.

3. In clinical ward walks and study he is able to discuss intelligently and understand the more frequent types of pathology which are demonstrated to him.

4. He is able when attending medical meetings to appreciate and understand pathologic roentgen demonstrations upon lantern slides or films shown there.

5. He understands the value of a careful X-ray study of a case as against a casual or careless study.

6. He receives sufficient instruction to enable him to understand the dangers of this work—from electrical shock, from over-exposure during film and fluoroscopic studies—and also the great danger of X-ray therapy in unskilled hands.

7. He makes a more valuable interne in hospital work.

8. He is able to correlate his physical examinations with the actual pathologic condition which he finds in a patient and to decide for himself where he can place the most dependence in the different methods of examination.

9. His instruction in therapy will aid him in prescribing properly for many of the skin lesions and also in appreciating what he may expect from X-ray in semi-malignant and malignant neoplasms.

10. His own and the patients' health will be safeguarded by his understanding the reason for proper protection if he undertakes work requiring exposure to the X-rays; and finally

11. He has received sufficient instruction to show him that he has only scratched the surface of this important subject and that if he should decide to go further into it he must put in more work. This point alone will make, I believe, for the production of more careful roentgenologists, as well as a demand for careful roentgenologic studies.

A DEVELOPMENTAL STUDY OF THE NASAL ACCESSORY SINUSES[1]

By W. WALTER WASSON, M.D., DENVER, COLORADO

IT has been and is common teaching that infants do not have infection of the paranasal sinuses as the sinuses are too small, and if one should find infection in older children it must be considered a fairly normal condition. These two statements would seem to be in opposition to each other and not well founded. In fact, there are already plenty of observations recorded in medical literature by careful workers to refute these statements. Warren Davis reports the necrotic destruction of the anterior bony wall of an antrum in a child 13 days of age, and an orbital abscess from ethmoidal infection in another infant 8 weeks of age. Dean records the death of infants from paranasal sinusitis at 2 months, 6 weeks, and 16 months. Andrews had a case with necrosis of the sphenoid at 6 years. Byfield found asthma in children with sinus infection at 8, 11 and 12 years of age. Haike reports 62 necropsies in infants and children from 9 months to 13 years of age in which 52 showed paranasal sinus disease; 47 were infections of the antra. Of 50 cases coming in for tonsil and adenoid operation, White found 41 had sinus infestion, and concludes that the sinuses are not too small to be infected in infants. These observations, then, place paranasal sinusitis before us as being of considerable seriousness and of frequent occurrence. Certainly the subject will bear careful investigation and perhaps greater emphasis.

Let us consider first the paranasal sinuses in animals. These are found to develop gradually until the extinct sloths had air spaces surrounding the upper, back and side walls of the head (Holden). The elephant has similar large sinuses surrounding the brain. In the ox the frontal sinuses extend into the parietal and occipital bones and out into the horns. The horse has well-developed sinuses, and other animals vary according to species. Chauveau concludes that these sinuses have nothing to do with olfaction or respiration and are intended only to give additional volume, without additional weight, and to add strength on the principle of the hollow girder. They are, however, concerned with the development of the teeth and the resonance of the voice (O'Malley).

It is interesting to note that many animals have paranasal sinus infection. Youatt writes of frontal sinus infection resulting in infection of the brain in the horse, and describes a chronic as well as acute forms of paranasal sinusitis. Some animals are known to have their sinuses infested with maggots. It would seem, then, that the human being is not alone in the affliction of paranasal sinusitis and that there are good explanations for the finding of sinuses varying from small to very large size in the present-day race.

Radiographs of the heads of mummies show similar conditions of the sinuses as to size and position as found in the people of to-day, and also considerable evidence of infection. Mr. J. A. Jeancon, of the State Museum of Colorado, has made an interesting observation of the Indians in New Mexico. At Santa Clara Pueblo, where there is no gross evidence of paranasal sinus disease, such as inflamed eyes and discharging noses, their word for "village" is "owinge," pronounced with a distinct nasal resonance. At San Juan Pueblo, situated in

[1]This work is being accomplished through the aid of the Selmene Winter Foundation. Paper presented before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

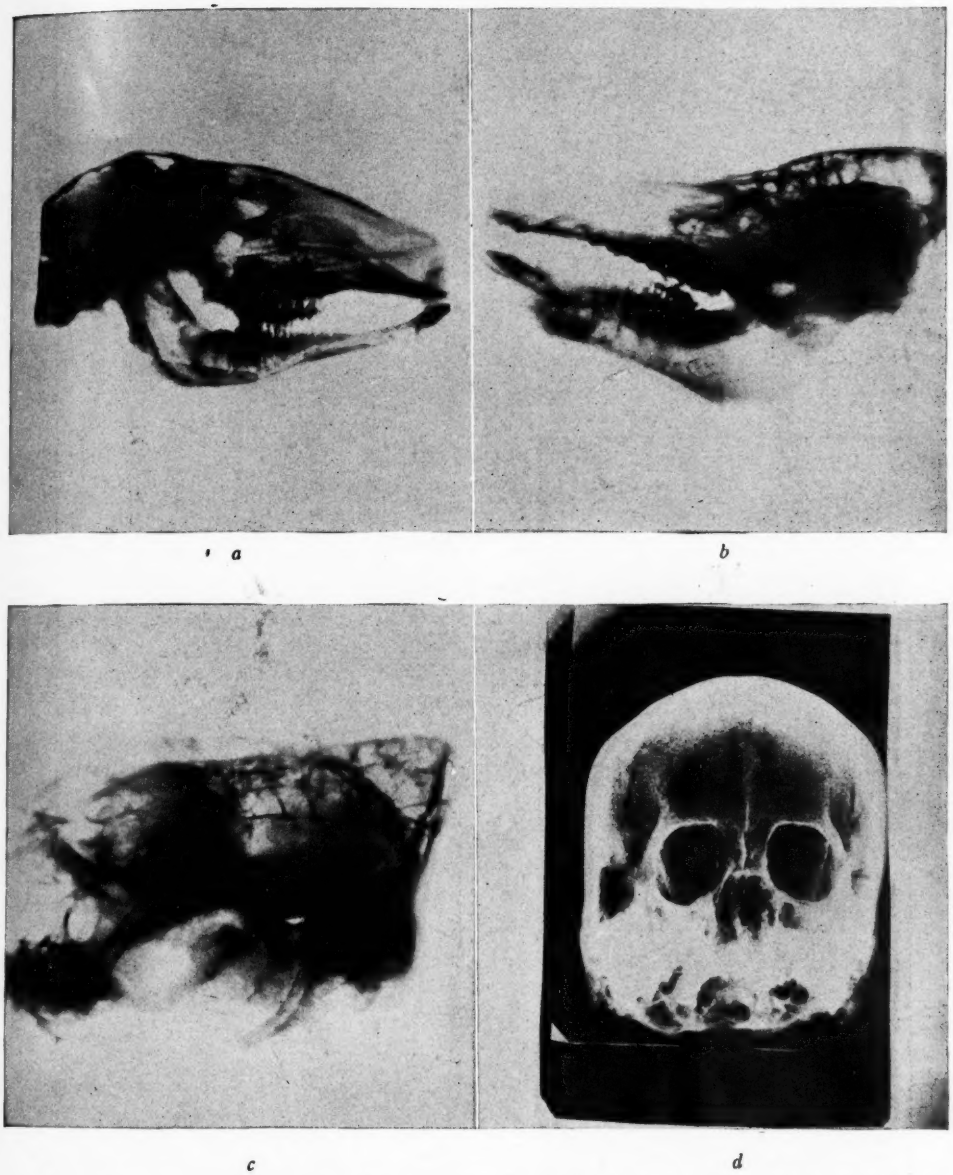


Fig. 1. (*a, b, c*) Radiographs of sheep, hog, cow, illustrating size of sinuses and their relation to volume of head. (*d*) Radiograph of Indian mummy about 3,000 years old, showing evidence of infection of right antrum.

a low swampy district six miles north of Santa Clara Pueblo, the inhabitants have inflamed eyes, discharging noses, swollen uvulæ and post-nasal catarrh, and their word for "village" is "ongwi," pronounced without the nasal resonance. We have, then, the same race of people using two different words for "village" because one

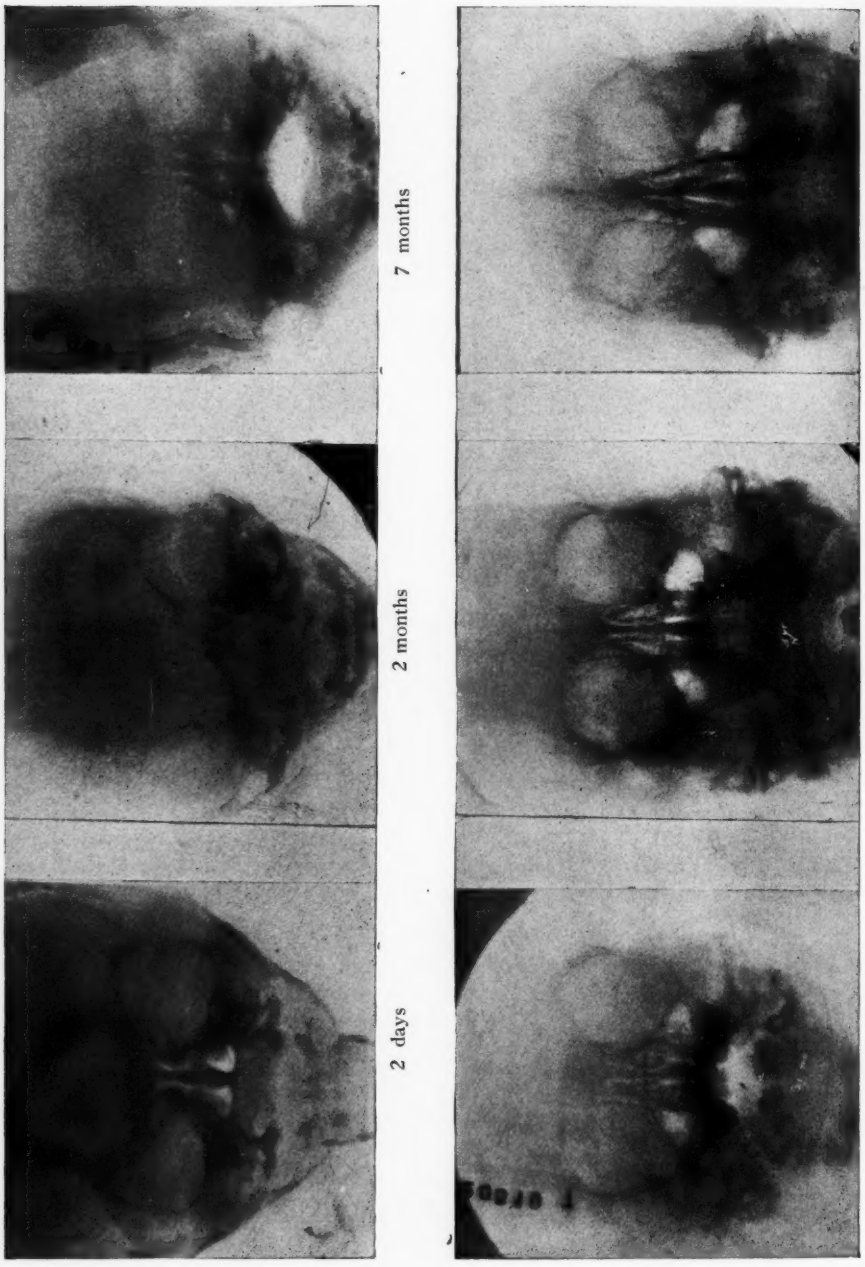


Fig. 2. Illustrations of size of the sinuses at varying ages on different children.

group could not pronounce words requiring the resonance of the nasal sinuses. In such manner disease will in time influence a race.

Let us now turn to the sinuses accessory to the nose of our own people of to-day. For the fundamental anatomy I can do no better than refer the reader to Schaeffer's text with its excellent descriptions, illustra-

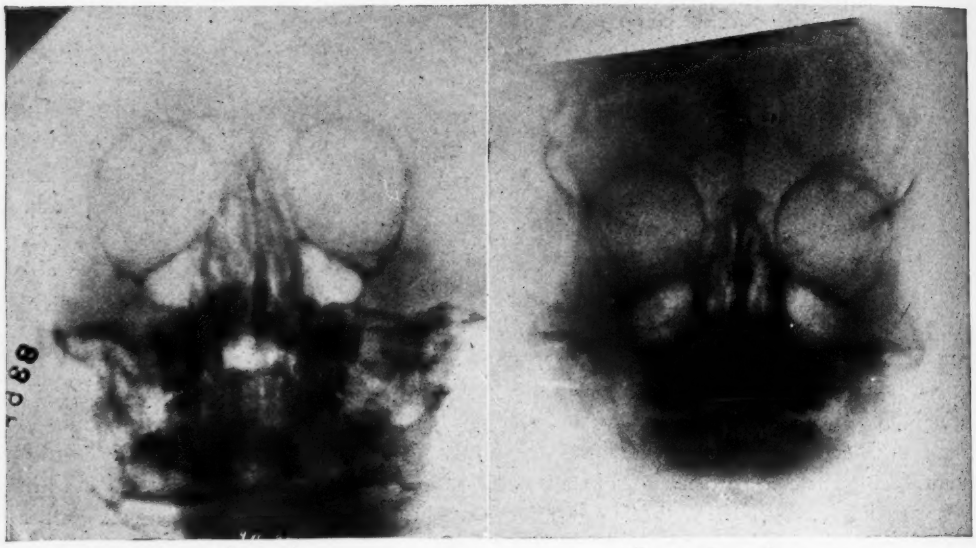
tions and charts of the various sinuses at varying ages. He finds that the antrum measures 7 × 5 mm. at birth, begins to enlarge especially at from two to three years, and reaches its maximum at from fourteen to fifteen years of age. The anterior ethmoid group measures 5 × 2 × 3 mm. at birth and the posterior group, 5 × 4 × 2 mm., and gradually develops until puberty. The frontal sinus is absent in the newborn and is first seen about the end of the first year, usually developing from the anterior ethmoids upward along the posterior wall of the frontal bone. By the third or fourth year this sinus measures 5 × 3.5 × 4.5 mm., and gradually enlarges until early adult life. The sphenoidal sinus is not at first surrounded by bone and it is only by absorption of the anterior wall of the sphenoid that this takes place. By the end of the third year it is entirely surrounded by the sphenoid and measures 5.5 × 4 × 2.5 mm. It gradually enlarges until adult life.

Complete agenesia of any of the sinuses is uncommon and both Carmody and Mitchell have spoken of the hindrance of development by infection. On the other hand, wide variance is found as to size, some of the sinuses approaching those previously described in animals. Thus the frontal sinus may extend beyond the frontal bone and into the parietal bone. The ethmoid cells may develop in a horizontal plane and encroach upon the frontal sinus. The sphenoidal sinuses may extend into the basilar portion of the occipital bone, the pterygoid processes and all portions of the sphenoidal bone. Likewise, there may be dehiscence of the wall of the ethmoids, with the mucous membrane in contact with the dura mater. It is difficult at any age, but especially so in the infant, to differentiate by the X-ray between the anterior and posterior ethmoids. The anterior cells may drain into the infundibulum ethmoidal and thence into the maxillary sinus by way of the ostium maxillare.

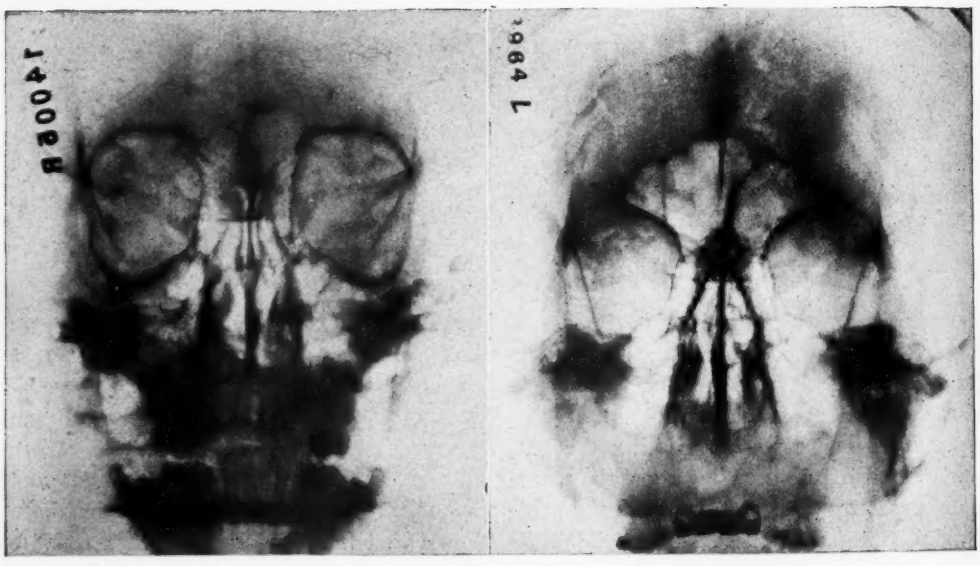
Many observers now place the radiograph second in importance to the clinical history in diagnosis, providing the technic is good and in the hands of a skilled radiologist (Irwin). It is not my desire to enter into a description of technic further than to say that we must use speed (1/4 to 1/20 sec. exposure), as the infant will not hold still. It is not necessary to anesthetize him, as taught in certain European clinics and also in some of our cities. Mitchell has described a 1/10 sec. technic. The position is varied as needed to portray the various sinuses. By such methods I find it possible to have just as excellent radiographs in infants as in adults, and the diagnosis is perhaps simpler, when one is once familiar with all the conditions to be met, as there are not years of preceding pathology to confuse one.

Having, then, the facilities for rapid exposure in sinus radiography it becomes possible to study the paranasal sinuses at any desired age. This is best done not by the selection of children at random and of varying ages, nor by the study of those who come in with symptoms pointing to the nose and throat, but, rather, by the study of a number of children from all the various walks of life from the time they are born through to adult life. Such a method I have previously described in connection with the chest,[2] and this same plan has been applied to the nasal sinuses. There have been many findings of interest and importance. In the first place, it has been found that the radiograph is quite accurate in its portrayal of the anatomy and its pathological variation, and checks very closely with the physical examinations as made by Dr. Carmody and Dr. Greene. Many times, however, when the clinical history

[2]Radiography of the Infant Chest, with Special Reference to the "Progression of the Chest and the Determination of the Normal," W. Walter Wasson. RADIOLOGY, November, 1925.



4 years 9 months 7 years 6 months

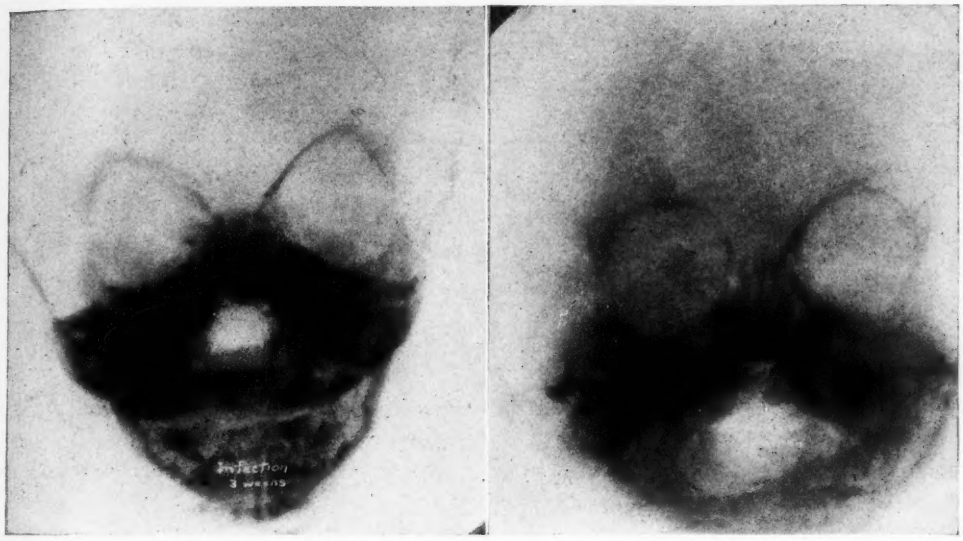


10 years 19 years

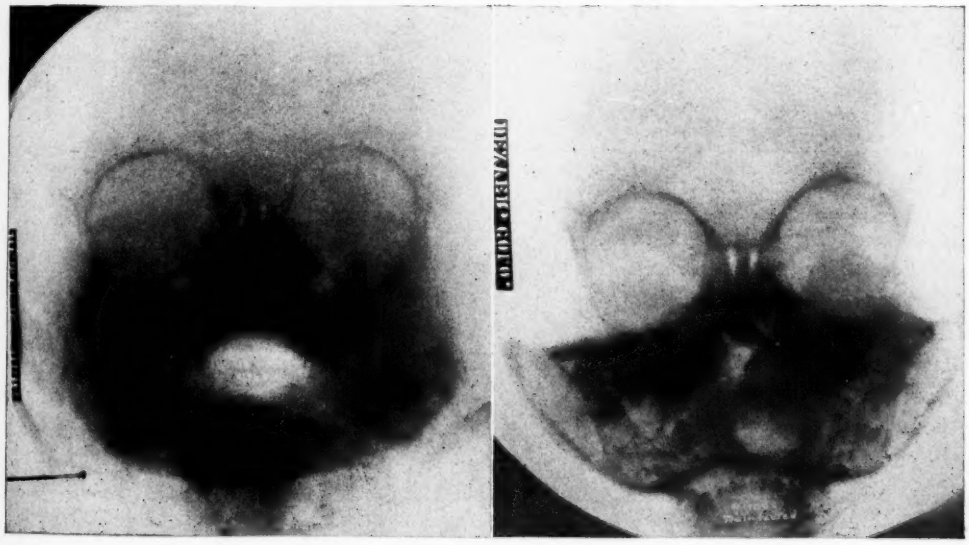
Fig. 3. Continuation of Figure 2.

points to no pathology in the nose the radiograph will show considerable involvement of one or more of the sinuses. In fact, practically every infant, if followed closely enough from birth, will at some time show infection of one or more of the paranasal sinuses. Many of these clear readily and do not show a return of the trouble, at

least not immediately following. Others will have a tonsil and adenoid operation—sometimes with clearing of the sinuses and at other times not. I recall one such case that had a tonsil and adenoid operation in the Fall, in which the sinuses did not clear

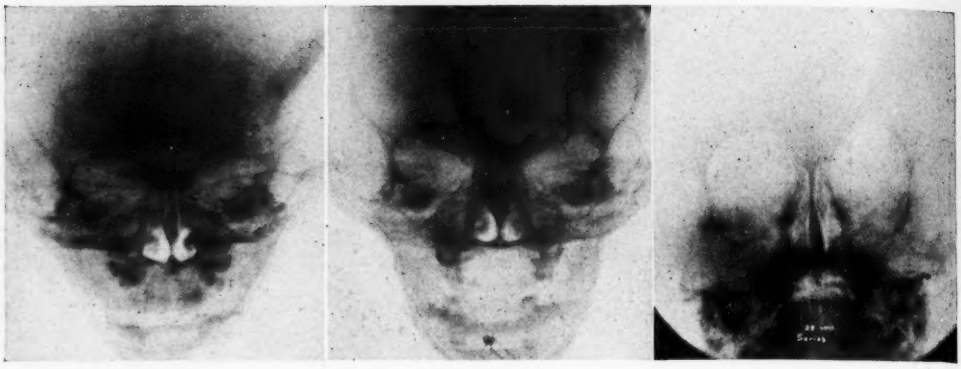


3 weeks 9 weeks



13 weeks 9 months

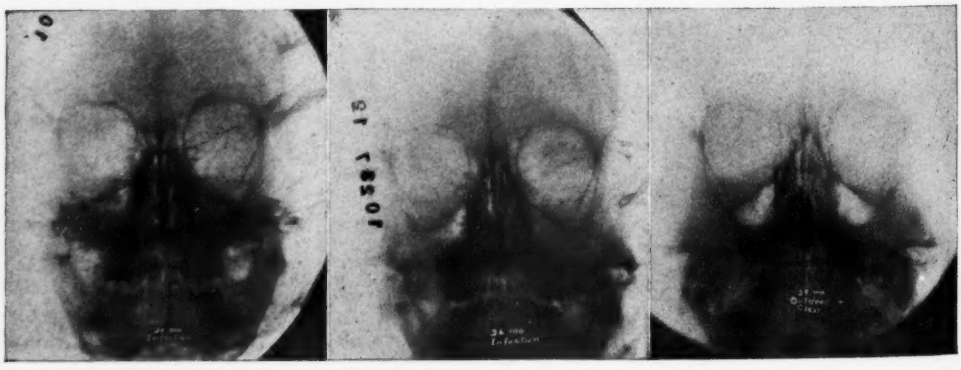
Fig. 4. Sinuses of an infant from three weeks to nine months of age, showing infection, moderate clearing, and re-infection.



10 months 19 months 28 months

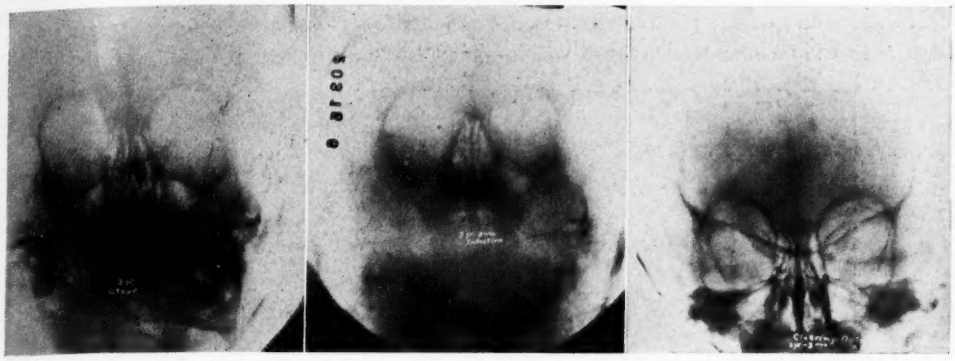
Fig. 5. Sinuses of an infant from ten to twenty-eight months of age, showing pansinusitis.

until the following Summer. Many patients that show infection of the sinuses in the Spring, if out of doors in good environment during the Summer will gain in bodily strength, and in the Fall radiographs of the sinuses will show them to be clear. This would seem to be in support of conservative treatment, as advocated by Dean, rather than radical operation. At this point I would urge conservatism in treatment of the sinuses, especially in infants, as operations are so often disastrous; this field is yet too young for the practice of surgery upon these tiny infants to become too widespread in the general medical profession. General upbuilding of the infant's physical condition, with local treatment of the nose, and operations reserved for the more chronic cases and those showing some defective anatomy, would seem to be the methods of choice. It must be remembered that the bony wall surrounding these sinuses in young infants is very delicate and at times even absent. In such cases, if operation is



a, 34 months *b*, 36 months *c*, 39 months

Fig. 6. Illustrating the beneficial results from outdoor life. (*a* and *b*) Show definite sinus infection, with tonsils removed after (*a*) but without results, as shown by (*b*). (*c*) Illustrates results from three months' outdoor life.

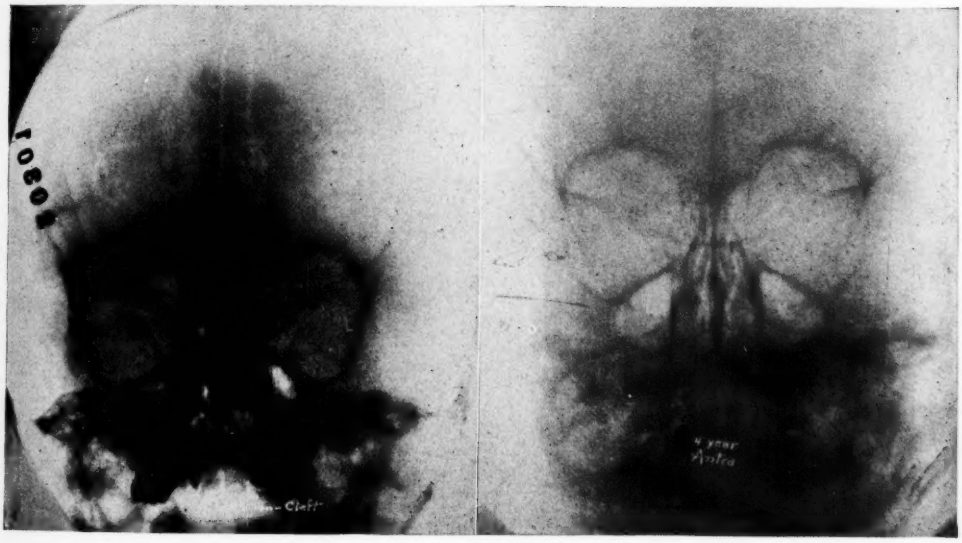


a, 3 years *b, 3 years 3 months* *c, 3 years 8 months*

Fig. 7. Sinuses of child showing no evidence of infection in (*a*). Marked involvement in (*b*). Clearing in (*c*) from three months' outdoor life.

not performed the infection may spread rapidly through these thin partitions into the neighboring structures. If operation is performed, these barriers may be broken down, with disastrous results. Considerable experience and good judgment is, therefore, quite necessary.

The fact that a sinus will appear dense owing to infection and then later clear, leaving apparently no trace of the previous infection, again raises the question as to what really accounts for this increased density. No doubt some of this clearing is due to the resumption of the pneumatization of the



a, 3 years *b*, 4 years

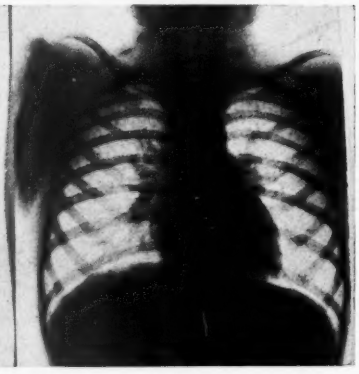
Fig. 8. (*a*) Illustrates tendency of cleft palate cases to sinus infection. (*b*) Illustrates growth of antrum downward and outward resulting in greatest radio-translucency in upper portion.

bone and to the absorption of the congestion in the lining of the particular sinus involved. In the more chronic cases these inflammatory processes become *so* chronic that they cannot be completely absorbed, but leave an increased density of the lining

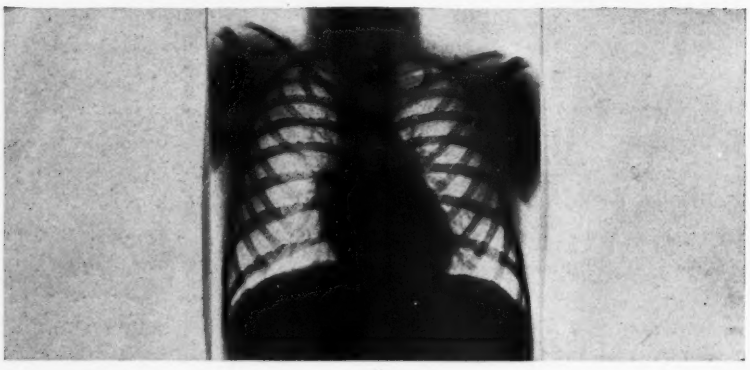
a, 21 months

b, 21 months

c, 5 years



d, 5 years



e, 5 years

Fig. 9. Different radiographic appearances as found at root of lungs. (*a* and *b*) Clear sinuses and no evidence of infection at root of lungs. (*c*) Has ethmoidal infection, and (*d*), same case as (*c*), illustrates typical changes at root of lung as found associated with upper respiratory infections. (*e*) Radiographic findings at root of lungs most typical of tuberculosis. The process is not so closely limited to the hilum as in (*d*) and shows more tendency to extend into the adjacent lung tissue.

a *b*

Fig. 10. (*a*) Radiograph of head of man at 50 years of age, showing increased density of bone about sinuses as found in cases of chronic infection. (*b*) Head of woman 70 years of age, showing definite changes in bones about sinuses, with long-standing infection.

membrane and even of the bony walls, as seen on the radiograph.

The antrum is observed at first to lie high and to the inner side of the orbit but later it grows downward and outward, and at this time will show a double shadow, owing to the increased antero-posterior depths in its upper portion. It must also be remembered that under three years of age the spenoidal sinus will probably not show, inasmuch as it is not surrounded by bony structures.

The great prevalence of infected paranasal sinuses, even in very young infants and perhaps before there is much evidence of tonsillar or adenoidal involvement, would raise the question as to which often comes first—infection of the sinuses or of the tonsils. No doubt they often go hand in hand, and yet Leyda, by the injection of argyrol into the nose, has shown that the drainage from the sinuses is down over the adenoids and tonsils.[3] Such questions may also be raised in regard to infection of the lungs, and especially the hila. Mullin has described the drainage channels from the paranasal sinuses and pharynx into the mediastinum, and certainly the involvement of the hila shows a characteristic radiograph when associated with sinus and tonsillar infection. Such radiographic findings of infected sinuses, with the characteristic involvement at the hila, constitute a picture so typical that one can usually state that this infant has definite bronchitis or its sequela, asthmatic bronchitis (Cunningham).

I cannot at this time show a definite, proven connection, in a series of radiographs upon the same individual, between the findings of paranasal sinuses in an infant or child and the adult, and until such can be done we can only draw upon our statistics and to a certain degree upon our imaginations. But certainly the inference must be drawn at the present time that, with the prevalence of infection of the sinuses in the infant and child, these infec-

[3]Manifestations of Paranasal Sinusitis, James Leyda. Read before the Colorado State Medical Association, at Colorado Springs, September, 1926; unpublished as yet.

tions were the forerunners of the chronic sinusitis in the adult. This is especially true when the findings in the adult are indicative of a long-standing process, even to the extent of characteristic changes in the bones of the face and base of the skull. The adult sinuses, therefore, depend for their size and character upon the pathology which has taken place in early life. The reports of various observers favor the antra as the most common source of infection and the ethmoids next. In my own observations I feel that the ethmoids are the most important in production of hay-fever and asthma.

CONCLUSIONS

(1) Good radiographs may be had of the paranasal sinuses in infants, and are quite accurate in their portrayal of the anatomy and pathology.

(2) The true story of the paranasal sinuses cannot be told until a complete study by radiographs, physical examinations, clinical histories, etc., has been made upon a series of individuals from birth through adult life.

(3) Infection of the sinuses in infants is very common and is of the greatest importance to both the present and future health of the individual, such infection being a contributory factor to many of the diseases of the body.

(4) The treatment of the chronic paranasal sinusitis in the adult is the treatment of an end-result from many previous years of tragedies and should be corrected by the proper education of the medical profession and the public.

BONE DISEASES IN INFANTS AND CHILDREN[1]

By PHILIP LEWIN, M.D., and EDWARD L. JENKINSON, M.D., CHICAGO

IN a previous paper[2] the writers discussed briefly many of the most common bone and joint diseases occurring during infancy and childhood. It is their purpose now to emphasize some of these conditions, especially rickets, tuberculosis, syphilis, non-specific epiphysitis, osteochondritis, coccidioidal granuloma, glandular disbalance and nutritional disturbances other than rickets and scurvy.

RICKETS

The roentgenographic findings in rickets are quite characteristic. The disease is prone to attack the ends of the bones, most of the changes occurring near the epiphyseal line. The shafts of the bones are soft and curved, due to the lack of calcium. The writers see comparatively few fractures of rachitic bones.

The epiphyseal line is irregular and hazy. The diaphyseal line is irregular and shows the characteristic saucer-shaped deformity. The epiphysis is softened, often mushroomed, and usually enlarged. The joint surfaces are irregular and poorly developed. The periosteum is normal, as a rule. There is usually thickening of the cortex on the concave side.

There may be a definite rosary, with large nodes, at the sternal end of the ribs, which may cause an atelectatic band across the lungs, due to pressure.

ADOLESCENT RICKETS

There is discussion of the question as to whether it is a definite entity, that is, a condition *de novo* or a recrudescence of an infantile condition that has remained dormant during a period of comparative osteogenetic inactivity. It is the writers' belief that it does occur in patients who have no evidence of rickets, for example, at the age of ten years and develop deformities between the tenth and fourteenth year. This subject, together with its relationship to renal dwarfism, is discussed more fully by one of us in *Surgery, Gynecology and Obstetrics* for July, 1922.

SCURVY

Scurvy is a very rare disease in our experience, probably due to the improved prophylactic methods of feeding children. The majority of very young infants are now given fruit juices of various kinds, even in the humblest of families.

The characteristic changes occur just behind the diaphyseal line. In this region the typical Trommer's line is found. This line is an area of decalcification presenting the appearance of a second epiphyseal line. The periosteum is elevated, due to hemorrhage, which causes a stripping of that structure. This hematoma may undergo calcification. The degree of deformity depends upon the amount of hemorrhage. The epiphysis and the epiphyseal line are normal, as are the joint surfaces and the joint spaces. The shaft may show definite thickening on the convex side. There is no change in the medulla except in the region of Trommer's zone. In the severe types there is a great deal of atrophy of disuse, due to the great pain, which is aggravated on even the slightest movement. A severe grade of scurvy is one of the most painful conditions an infant may have. There is usually an accompanying hemorrhagic gingivitis and, if teeth are present, they are the seat of nu-

[1]Presented before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

[2]Am. Jour. Roentgenol. and Rad. Ther., February, 1927.

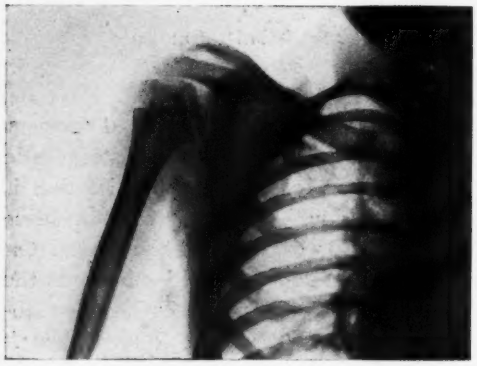


Fig. 1. Osteochondritis deformans juvenilis of the shoulder joint. Note the flattening of the medial and inferior surface of the head of the humerus, with fragmentation. Well developed cervical rib. Age, six years.

tritional disturbances. The writers have never seen a pathological fracture in scurvy.

LUES

Lues manifests itself most frequently in the lower ends of the femora, the ends of the tibiæ, the distal ends of ulnæ, radii and metacarpals, in the order named. No bones are exempt; even the vertebræ, ribs and the skull may be affected. The lesions are usually multiple but may be confined to small areas.

The shadows are due to changes in the calcification of the proximal cartilages and to abnormal arrangement of the osseous tissues. In the fetus the changes are confined to the epiphyseal-diaphyseal junction except in the severe cases. The periosteal changes are secondary to the endochondral defect, and take place after birth. There is a definite sclerosis of bone at the epiphyseal line. The bone seems to have a very thick cap, due to increased calcification. The provisional calcified zone is much wider in lues than in the normal, measuring 0.5 to 1.5 mm. The thick band may be confused with the band found following the treatment of rickets. There is often a clear zone separating the cortex from the spongiosa. There

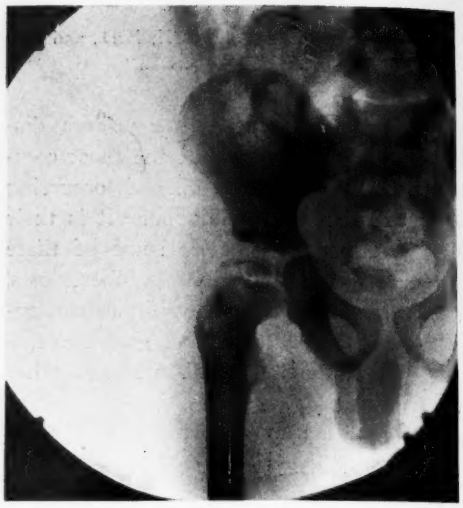


Fig. 2. Legg-Calvé-Perthes' disease—late stage.

is no interference with the growth of the bone.

Lues does not affect the epiphysis or the epiphyseal line; the articular surfaces may be normal. The characteristic findings are located at the diaphyseal line, where irregular, gouged-out areas can be seen. The shafts of the bones show changes, such as thickening of the cortex, seen in saber tibia. This thickening of the cortex is more evident on the convex side, in contrast with rickets; the periosteum, also, is usually thickened. Deformities are very common and may be of extreme grade. Fractures are uncommon in the experience of the writers.

There is usually a great deal of swelling of the peri-articular tissues, accompanied by fluid in the joint.

Christie has described a crescentic lesion which he finds quite characteristic of syphilis.

TUBERCULOSIS

The roentgenographic findings of haziness or clouding of the joint space, together with narrowing, bone atrophy and bone destruction, are characteristic of tuberculosis.

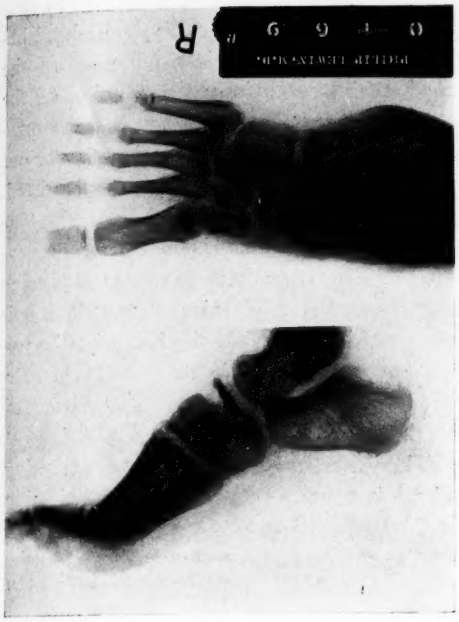


Fig. 3. Bilateral tarsal scaphoiditis (Köhler's disease).

Under three conditions, *viz.:* secondary infection, calcification of an exudate, and periosteal involvement, one may observe bone production. Allison states that tuberculosis, syphilis and gonococcal infections may be indistinguishable roentgenologically and oftentimes it is impossible to differentiate tuberculosis from syphilis in microscopic sections of tissue.

Phemister's work on the differences in destruction of cartilage in tuberculous and pyogenic arthritis is very important. He states that in pyogenic arthritis the cartilage disappears first at the points of contact and greatest pressure of opposing surfaces. In tuberculous arthritis the cartilage is destroyed first in the region where it is not in contact with opposing articular surfaces. Aspiration, biopsy and guinea pig inoculation tests may be necessary in order to make the diagnosis. The various tuberculin tests are of importance in the very young.

Fig. 4. Coxa vara.

NON-TUBERCULOUS EPIPHYSITIS

Epiphysitis occurs as a rule between the ages of three and fifteen years. The disease often follows injury, infection, glandular involvement, or a combination of these factors. Pain, limitation of motion, spasm, etc., are less marked than in tuberculosis. The epiphysis is the part of the bone affected, although the process may extend into the joint. At first there is swelling and edema of the soft tissues, but no abscess formation as a rule. In contrast to tuberculosis, the outlines of the bones are usually sharply defined and a good film can be obtained. The epiphysis becomes rarefied and reveals multiple small areas of bone destruction, often widely separated. The infection is usually confined to one joint, although it may be multiple. In the case of the upper end of the femur, if weight-bearing continues, the head of the femur will become deformed; if the infection is severe, it will be destroyed. Unlike a tuberculous process, there is often considerable bone production followed by bony ankylosis. This fact affords one a point of diagnostic value in differentiating acute non-tuberculous epiphysitis of the hip from Legg-Calvé-Perthes' disease, in which latter condition ankylosis does not occur. It is quite common to see the infection spread through the articular

surfaces and involve the acetabulum in epiphysitis, while in Legg's disease this does not occur.

In epiphysitis the diaphyseal line may show areas of destruction in the earlier stages, and, as the disease subsides, the line may become calcified. The shaft, cortex and medulla are as a rule not involved. Fractures are very uncommon in these cases, but an epiphyseal separation or epiphyseal slipping is frequently observed. There is a type seen in cases of Froehlich's syndrome (dystrophia adiposogenitalis). The child is considerably overweight and sex characteristics are delayed or abnormal.

OSTEOCHONDRITIS DEFORMANS COXÆ JUVENILIS—LEGG'S DISEASE

Legg-Calvé-Perthes' disease usually occurs between the ages of four and ten years, with the typical history of a minor injury following which the child develops a slight limp, with some limitation in abduction and external rotation. These cases were formerly thought to be tuberculous but the idea was abandoned as they usually improved too rapidly to have been true cases of tuberculosis. At present the cause of the disease is not agreed upon, many different opinions having been offered but none universally accepted. There are some who believe lues to be the cause, while others attribute the changes to atrophic or congenital disturbances. Freiberg believes the disease is due to an infection and traces some of his cases to—and following—tonsillitis. One of the writers (P. L.) has personally talked with Legg, Calvé, Perthes, Jansen and Calot, all of whom have written extensively on this subject, and they all disagree on etiology and treatment. The disease attacks the head and neck primarily; it may be bilateral but is usually unilateral. It begins in the head of the femur. The outlines of the bones and joints are quite sharply defined, in contrast to a tuberculous lesion. The head becomes soft and there is a widening of the neck, with proportionate narrowing of the shaft. As the disease progresses the rarefaction increases. If the patient is not put at rest and if weight-bearing is permitted, the head becomes flat and deformed. The degree of limitation of motion and permanent deformity in later years depends upon the amount of mechanical deformity; it is not uncommon to find the bones of the pelvis on the affected side atrophied. Atrophy of the soft tissues is present, but less marked than in tuberculosis.

The disease is practically self-limiting. There is usually one year of the softening, followed by hardening and rebuilding. If during the stage of softening leg extension is used, much of the deformity can be prevented.

The roentgenographic findings during the first year show very soft bone, while during the second and third years the bone becomes more dense and repair takes place, a condition of condensation which may be quite marked. The head seems to possess the power rapidly to rebuild its structure, which is in marked contrast to conditions in infectious epiphysitis. Fragmentation of the head may occur, likened to a head made of ice struck by the handle of an ice-pick (Porter).

Cases have been described of similar involvement of other bones and joints. At present it seems fair to state that there is an important group of conditions that have many characteristics in common, *viz.:* Legg-Calvé-Perthes' disease of the hip, Osgood-Schlatter's disease of the upper tibial epiphysis, Köhler's tarsal scaphoiditis, Freiberg's infraction of the metatarsal heads, apophysitis of the os calcis, Scheuermann's kyphosis dorsalis juvenilis and Calvé's vertebral epiphysitis. Stern, of Cleveland, has demonstrated a similar condition in the lower tibial and fibular epiphyses. One of us

(P. L.) has seen the condition in the lower femoral and upper humeral epiphyses.

In discussing the etiology of vertebral epiphysitis one of us (P. L.) has said: "The etiology of this condition is found in the following factors: firstly, infection locally and remotely; secondly, circulatory disturbances in the nature of embolism, thrombosis, etc.; thirdly, trauma both internal and external, and fourthly, glandular disturbance affecting bone growth and development."

OSTEOMYELITIS

This disease is very common in the upper tibia and lower femur, as these regions are subject to many injuries, while the upper extremities are less frequently attacked. The epiphysis and the articular surfaces are involved late in the severe types of infection. The epiphyseal line serves as a barrier, therefore the infection extends into the epiphysis and joint in the fulminating types only. In the pure hematogenous types with no history of an injury the diaphyseal line or its close proximity is the favorite site. In the traumatic types it is not uncommon to find the disease in the shaft of the bone, especially in the tibia. It starts in the medulla and later extends into the cortex, causing destruction of the dense bone and finally affecting the periosteum. The cortical portion of the bone derives its blood supply from the vessels of the periosteum and the medullary part from the nutrient arteries.

Fractures may occur in cases of osteomyelitis that have been operated on and in which considerable bone has been removed. The degree of deformity depends upon the extent of the process and the correction of the fracture.

In the early diagnosis of osteomyelitis a roentgenogram is usually of very little help. The surgeon must not wait until roentgenographic changes have occurred before operating, as valuable time may be thus lost. If the infection has existed for some time, there may be certain changes in the region of the medulla that will arouse suspicion. The medullary portion of the bone may be hazy and there may be loss of definition in the early stages of the disease; in fact, the first roentgenographic sign is thickening rather than absorption. The relative increase in density may be due to reaction to inflammation, such as the influx of leukocytes and a certain amount of edema. Following the increase there will be decrease in the density due to absorption.

There are no signs from the roentgenological standpoint that are characteristic of any type of infection, the roentgenologic diagnosis depending upon the amount of bone destruction and proliferation. There are certain findings accompanying infections that may give one an idea, but they are not definitely differential. One must be content to say there is evidence of an infection.

In osteomyelitis of the bones of the hand, oftentimes the findings, together with the history, may give some clue as to the cause of the infection. In syphilitic and tuberculous dactylitis there are certain clinical findings which, when considered with the roentgenograms, may be helpful in making a diagnosis. The clinical findings in syphilis are not so severe as roentgenograms would lead one to believe, while in tuberculosis the clinical findings are quite parallel with roentgen-ray findings. In any form of osteomyelitis there often develops a sequestrum and involucrum.

There are a few points that may be of help in the differentiation between malignancy and infectious lesions. It is not uncommon to find areas of normal bone between areas of destruction in osteomyelitis; this is not true of malignancies. If the infection is very virulent there will be extensive bone destruction and no proliferation of new bone. Throughout the medullary cavities vacuolated areas due to absorption can be seen. Between these vacuolated areas there are islands of normal

bone, in contrast with malignant lesions which start at a central point and usually spread equally in all directions. Another important point in differentiating malignancy is the presence of a sequestrum. In our experience malignant disease never produces sequestra.

In chronic osteomyelitis there is new bone production beginning at the edge of the infection, an effort on the part of Nature to limit the process. The bone is not expanded, as in benign lesions, but is widened by the deposition of new bone on the outside. This proliferation of new bone may entirely obliterate the medullary cavity. If the infection starts in the epiphysis due to a wound, it will spread in all directions and may pass through the joint. This is a valuable differential diagnostic point because, in the writers' experience, malignant disease does not pass through a joint. The periosteal reaction may also be of importance in distinguishing osteomyelitis from malignancy. In malignant lesions the new bone is usually laid down perpendicular to the shaft, while in osteomyelitis it is parallel to the shaft.

STILL'S DISEASE

Arthritis deformans in children is characterized by atrophy of bones and deformity of joints which may be extreme. The glandular system is usually involved in that tonsils, regional lymph glands, spleen or liver may be enlarged. It is thought by some to bear a definite relationship to tuberculosis; by others, to focal infection such as in the tonsils.

In a case of the writers under observation at present the condition started three days after the removal of infected tonsils. The bone changes differ from those of the adult in that no exostoses are found.

The roentgen findings are not characteristic. There is usually a decalcification of the bones, making it impossible to obtain good roentgenograms. The joint surfaces are irregular and there is an accompanying narrowing of the spaces around the joints. The soft tissues are swollen. The condition is multiple, the hands, wrists and knees being most often involved. Due to the involvement of the epiphyses, which fuse with the diaphyses too early, there is stunting of growth.

COCCIDIOIDAL GRANULOMA

Coccidioidal granuloma is a disease caused by the *Coccidiodes immitis,* commonly called "California disease." It is often confused with blastomycosis, and the two diseases can be differentiated only by culture, as each has definite cultural characteristics. The *Blastomycetes* show definite budding, whereas the *Coccidioides* produce endospores. There have been about forty-five cases of the latter condition reported, forty of which occurred in the San Joaquin Valley. The writers' case had lived in the valley for some time. The disease is prone to develop in laborers, especially males; only one case in a female is reported in the literature. The case here reported makes the second.

The disease usually starts in the skin of the feet and hands and produces papules, nodules and later ulcers, which break down. The lesions are quite similar to those of tuberculosis and syphilis, the findings from both the pathological and the roentgenologic standpoints being very similar to the former. The nodules, according to Hektoen, cannot be differentiated from those of tuberculosis. In some of the cases the disease has been thought to have started in the lungs. It is accompanied by an adenitis, which is not true of blastomycosis. Meningitis is prone to develop during the course of the disease. There is usually a marked loss in weight, accompanied by fever and a high leukocyte count. According to the literature there have been three recoveries, in each of which

amputation of the extremities in which the lesions occurred have been performed. The writers' case is still alive and seems to be holding her own, although roentgenological changes in the lungs are progressing. The bone changes are very similar to those seen in tuberculosis. There is a definite area of destruction in the first metacarpal and one in the patella. The process has not destroyed the cortex, but there seems to be some swelling of that structure; so far, it has not extended into the joint surfaces. In the center of one of the metacarpals there is a relatively large area which has the appearance of very soft bone. So far, in the development of the disease, there has been no evidence of new bone formation. In the patella the process seems confined to the medullary part of the bone, with no evidence of invasion or new bone formation. The lungs are studded with many small circular areas of increased density not unlike a disseminated tuberculosis. At the first chest examination nothing of importance could be seen in either lung; since that time there has been a gradual increase in the small tubercle-like areas. When the first roentgenologic examination of the metacarpals was made, the lesion was thought to be either a syphilitic or a tuberculous dactylitis. At a later date the skin lesion on the knee was opened and smears taken. Dr. E. F. Hirsch, the pathologist, thought the condition to be due to blastomycosis, but, after culturing, found the endospores of the *Coccidioides immitis* and made the definite diagnosis. After frequent examination of the patient and careful studies of the films, one is still unable to see anything of definite differential diagnostic value. The patient is a negro girl ten years of age, referred by Dr. S. C. Plummer.

RADIO-ACTIVE SUBSTANCES: THEIR THERAPEUTIC USES AND APPLICATIONS

THE VALUE OF RADIUM IN THE TREATMENT OF MAMMARY CARCINOMA

By JOSEPH MUIR, M.D., New York City

EVER since medical history began to be written a great deal of attention has been accorded to breast tumors. With the advent of scientific pathology the different types of tumor have received notice in some measure proportionate to their importance, and so it has come about that mammary carcinoma, the most prevalent form of malignant growth affecting that portion of the body, eventually supplied a subject around which an enormous body of literature has accumulated. It seems safe to say that to no other form of malignancy has so much analysis, examination, and statistical tabulation been directed, nor so great diversity of opinion as to treatment prevailed. Indeed, so much has been said and written that one almost despairs of ever arriving at a just analysis of these varied and conflicting claims, or of deciding whether, among so great multiplicity of information and dogmatic assertion, any rational understanding has ever been attained. And even when the scope of one's inquiry has been restricted solely to the use of radium in the treatment of breast carcinoma, he still finds a bewildering mass of material to be gone over and evaluated, for the literature concerning radiation treatment alone is tremendous.

It seems wiser, therefore, to make no attempt to review *in extenso* the history of the employment of radiation in the therapy of breast cancer, and I shall, in consequence, confine myself to a discussion of those factors which must be considered before undertaking any kind of treatment, whether it be by surgery or physiotherapeutic agencies, merely citing examples from the reports of other workers which may serve to elucidate the points which I shall endeavor to attain in the course of my examination of the subject.

In the multifarious discussions upon breast cancer numerous attempts have been made to classify the various types of neoplasm which have been observed to originate in the mammary gland, and from such histologic study have emerged the terms "adenocarcinoma," "medullary carcinoma," "scirrhus," "colloid" and so on, but, as Greenough has recently remarked, with the exception of adenocarcinoma and colloid, these classifications have given little aid to the clinician. A few years ago, however, an attempt was made at the Mayo Clinic to classify cancer tissue according to the degree of its malignancy, and this idea has been followed up by a number of other clinics, the arrangement of breast growths having been undertaken by Greenough and Simmons of the Huntington Memorial Hospital in Boston. For the purposes of this study 73 cases of breast carcinoma were reviewed, all of which had been subjected to complete radical removal of the breast, and of which the investigators possessed satisfactory microscopic slides from the original growth and were cognizant of the end-results. The results of this study led those engaged in it to decide that the degree of malignancy of a given case of cancer of the breast can be determined with reasonable accuracy by study of the histology of the tumor, and three classes, which for convenience they designated as low, medium, and high malignancy, can be distinguished. They felt that this classification was of im-

portance not only in relation to prognosis, but also in the estimation of the value of various methods of treatment. High malignancy is shown by cells and nuclei of irregular shape and size without secretory function, and arranged in solid columns, large or small, together with numerous and irregular mitoses and hyperchromatism. The extreme degree of these features is pleomorphism, that is, the assumption of various distinct forms by a single type of cell. Low malignancy they found to be indicated when the cells of the growth showed an adenomatous arrangement, were uniform in size, with nuclei of similar dimensions, showed few mitoses and did not present hyperchromatism.

While these deductions are not put forward as incontrovertible, their value to the clinician will be evident even to those not versed in histologic investigation. The observations which he has made at the bedside have already shown that the adenomatous type of growth is more amenable to radiation treatment than growths of other types, but it has not been possible heretofore to establish this fact on anything like a scientific basis. Two years ago Bowing reported in this journal the observations upon four cases of inoperable mammary carcinoma which underwent radium exposure and were thereafter so much altered as to be deemed fit for amputation. Microscopic sections made from the breasts after removal were pronounced by Broders to be adenocarcinoma in three cases; "the other specimen was so completely altered that further classification was impossible." In general, these specimens showed that "the greatest amount of lymphatic infiltration occurs early in the reaction, although typical areas could be demonstrated, intimately associated with the carcinoma cells. Fibrosis was the outstanding condition. In many slides it was universal and intimately associated with degenerating carcinoma nests, and in some areas active carcinoma cells were found. Many phases of the degenerating process could be demonstrated. Certain areas were rich in connective tissue cells, while others were very poor, consisting chiefly of collagen fibrils, and resembling old scar tissue. Many fields contained hyalin, a structureless, pink-staining material. A few areas revealed the characteristic staining qualities of calcium deposits in this hyaline material, which would indicate a further and definite degenerative process."

It was the opinion of this investigator that the adenomatous type of carcinoma of the breast can be accelerated or caused to differentiate—thus reducing its rate of growth—following its exposure to radium rays. Similar changes were demonstrated by MacCarty in untreated carcinoma of the breast, and were regarded by him as a natural defense mechanism, "characterized by variable amounts of differentiation, lymphocytic infiltration, fibrosis, and hyalinization."

As "divided doses of radium cause prickle-cell carcinoma to differentiate, with the ultimate formation of cancroid pearls," and "the glandular type or adenocarcinoma has been caused to differentiate with the ultimate formation of simple cysts," the relation between the slow and uncertain process of natural repair, and the rapid reduction of size and inhibition of mitosis following radium application is apparent. Alter found some years ago that following intensive radiation there was a rapid change in the cancer tissue which he designated as "melting," less intensive radiation producing marked stages of differentiation which he termed "acceleration." The later degenerative processes were characterized by fibrosis. This fibrotic formation takes place soon after radiation has been undergone, but as yet the precise length of time has not been established. In a discussion of ante-

operative raying which took place at the 1921 meeting of the American Radium Society, it was stated that pathologic examination of axillary nodes excised immediately after radium exposure showed no fibrosis at all, whereas those in which radium-bearing needles had been left for forty-eight hours before removal displayed marked changes in tissue structure, the capsule surrounding the carcinomatous growth being greatly increased in thickness, although the size of the entire node was noticeably reduced.

Quite as important as the primary growth —at least in so far as treatment directed toward eradication is concerned—is the question of metastasis to the related lymphatic glands. The whole matter of glandular metastasis in breast carcinoma has been widely studied, but as yet no really satisfactory means of dealing with it has been evolved. There is, however, an ever-increasing tendency on the part of surgeons to avoid intervention upon the lymphatic glands even when they are palpably involved, but to leave the handling of this phase of the case to the radiologists. The considerations by which the surgeon is moved, however, should have just exactly as much weight with those who undertake radiotherapy, and unless they are fully grounded in anatomy and pathology, their efforts are likely to be futile. Any attempt to apply radiotherapy to any manifestation of mammary carcinoma should be preceded by most exact and careful study of all possible lymphatic involvement, and must of necessity include practical understanding of anatomic and pathologic relations.

A very masterly exposition of the spread of carcinoma originating in the breast is that of Fitzwilliams, of London, published in April, 1925. He argues that dissemination can take place only by embolic spread along the lymphatic vessels. More than half the cases of mammary carcinoma show enlargement of the axillary glands when they are first seen by the surgeon, but the fact that the glands are palpably enlarged does not necessarily imply that they are carcinomatous, "as there is nearly always an accompanying mastitis which can cause a well-marked adenitis." But as there are in most cases infected glands higher up in the axilla which cannot be palpated, it is impossible to estimate with any accuracy how much of the lymphatic system is infected in any given case. "What is important is the recognition that the infection spreads first along the lymphatic vessels in which the lymph flow is most active. None would pretend that any other set of glands was infected so early, so freely, or so often as those of the axilla, to which the ordinary flow of lymph is directed."

It is frequently found at operation that two or more glands far down in the axilla are carcinomatous, and thereafter no further traces of malignancy are encountered until the very apex is reached. This investigator believes the explanation of such a finding to be that one set of glands becomes infected and the flow of lymph retarded and eventually stopped completely, blocking the passage of any further infection by this route. "Meanwhile the collateral circulation opens up the channels between the two pectoral muscles and the glands upon the costocoracoid membrane and the very apex of the axilla becomes infected by cells carried by the lymph flow. Thus we find glands affected in one place, then unaffected glands, and again infected glands beyond, the growth in the third set being always less than the growth in the first set, as the infection is more recent. It is only as time goes on, and as the axillary paths become more and more blocked, and the collateral circulation becomes opened up, that the cells are carried toward the middle line in such numbers that they grow in the liver, peritoneal cavity, and mediasti-

num, and so cause the death of the patient." The importance of these observations to the radium therapist can hardly be overestimated. By far the larger proportion of the cases which come under his care are recurrent and inoperable, and in the management of the type of lesion there represented, the utmost resources of radium treatment must be marshalled, though there is now no question as to the value of this physiotherapeutic agent in staying the course of a disease which has thrown down the most impregnable barriers surgery has been able to place in its way. As to the advantages of radiation before and after operation, when the recurrence of the disease is only a possibility to be foreseen, not an actuality to be overcome, opinions, even among those of the widest experience, differ greatly. At present the tendency seems to be to omit any pre-operative radiation but to depend upon post-operative applications to clean up those areas of infection which the surgeon did not or could not reach. X-ray is used for this purpose more than radium, but everywhere that radium or its emanation can be readily obtained it is rapidly displacing the roentgenologic technic, as the emanation especially has been found exactly as effective and infinitely more adaptable to varied requirements than any form of X-ray exposure can be. The fact, too, that radium is relatively more expensive than X-ray must to a certain extent militate against its use when there is a choice between the two agents. And on the whole, it would seem that those clinics where both radium and X-ray have been used—in the majority of instances in conjunction with surgery—have been able to report the most satisfactory results.

The technic employed when prevention of recurrence is the object in view, and that used to combat recurrence which has already taken place, naturally differ considerably in detail, although the basic principle remains the same. As Lee, of the Memorial Hospital, speaking two years ago at the annual meeting of the American Medical Association, very pertinently pointed out, if prompt post-operative irradiation were undertaken in all cases of breast cancer, the need of irradiating inoperable recurrences would be reduced to practically nothing.

Beside these uses we must also consider those cases which are inoperable when first seen by the surgeon. These unfortunate patients have no other hope than that offered by radiation, and though the greater part of them are doomed to an early death, it is sometimes amazing to find what remarkable results have been obtained by the combination of X-ray exposure and radium application. A number of years ago Pfahler reported on a number of such cases, testifying that "the disease has either been made to disappear completely so far as inspection or palpation can determine, or, in those cases in which the disease involved a large mass of malignant tissue of the breast area, it was reduced to a fibrous solid mass, movable, which could then be removed locally by surgery. Axillary and even supraclavicular lymph nodes have been made to disappear."

The treatment used in these cases was primary radiation by roentgen rays, and, after a lapse of two weeks, insertion of steel needles containing 10 mgm. of radium element each. Under nitrous oxide gas anesthesia the needles were placed throughout the diseased area 1.5 cm. apart for an eight-hour exposure, or 2 cm. apart for a sixteen-hour exposure. When handling recurrences a similar series of roentgen-ray and radium treatments was carried out, although often, instead of inserting needles, the radium was employed in surface application, "with filtration equivalent to at least a millimeter of brass and with sufficient distance and time to get an effective distribution of

the radiation over the entire lesion involved. When radium is not at hand, more intensive X-ray should be used, sufficient to destroy the local disease."

More recent reports from other clinics give variations on this method, as, for example, that used by Lee and Tannenbaum at the Memorial Hospital. For the treatment of involved supraclavicular or axillary nodes, the infraclavicular fossa, the larger recurrences on the chest wall, or metastases to bone, a radium pack is employed, having a filtration of 1 mm. brass and 0.5 mm. silver, and capable of delivering 10,000 millicurie hours over an area of 70 square centimeters of tissue. Single recurrences of smaller extent are treated by a "tray" giving a maximum dosage of 3,000 mc. hours. Other small recurrent lesions have been treated by the implantation of bare tubes, but if these are in the axillary nodes, the bare tubes cannot be embedded except with the aid of surgery, and this does not often seem justifiable. Breast needles with 0.4 mm. of platinum filtration have been of service in the treatment of recurrent axillary carcinoma, or extension to the opposite breast, the dosage employed being approximately 70 millicurie hours per cubic centimeter of tissue treated. This last form of application has proved very satisfactory to these writers.

Implantation methods have not as yet proved very efficient in treating malignancy of the breast, but now that it is no longer necessary to make use of unfiltered seeds, it seems likely that the usefulness of this particular technic will be widely extended. A serious drawback to the employment of buried radium emanation in the breast heretofore has been the necessity of leaving the spent tubes in the irradiated tissues, and the hard nodules forming about these foreign bodies, while actually innocuous, so closely simulated recurrence of carcinomatous glands as to prove most disquieting to physician and patient alike. By using removable seeds, this drawback is likewise eliminated, and it is now possible to insure adequate and complete radiation of suspicious tissue without incurring any risk of causing necrosis, nor leaving behind any tangible evidence of the agent of application. As no anesthesia is required for their implantation the use of these seeds is particularly applicable to patients in whom cachexia is marked.

Radium as a treatment for carcinoma of the breast undoubtedly holds out almost unlimited possibilities for the future. Up to now it has been applied almost entirely to the most unfavorable types of lesion, for even when it has been the only treatment employed, its selection was due to the fact that the case was considered wholly beyond help by any other means. Greenough's observations go to show what a wide difference exists from the very beginning in the malignancy of mammary carcinomas, and an examination of the records reveals that where radium has been applied to the more favorable—because less malignant—adenomatous type the percentage of cure has very generally been high, distinctly higher than that of cases of similar histology in the treatment of which no radium was used. While these figures are very suggestive they are not, of course, conclusive, so despite the vast amount of work which has been done on the subject, and the ever-increasing mass of evidence being accumulated, we must still look to the future for a complete demonstration of the full value of radium in this distressingly frequent form of malignant disease.

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Cancer of lower jaw.—In this communication the author limits himself to those cases of carcinoma beginning in the mucous membrane over the mandible, with special reference to their treatment. These cases are all epidermoid carcinomas but show two distinct clinical types, infiltrating and papillary. He believes that infection around the teeth, retained root fragments, ill-fitting dentures, and excessive smoking are contributing factors. The surgical outlook in these cases is not good. The clinical cures would seem to be about 15 or 20 per cent from this method, and an average term of life from seven to ten months after consulting a surgeon.

In these cases the author recommends a combination of radiation therapy and surgery. Filtered radium and X-rays are used externally, after which fine capillary tubes of gold containing radium emanation are injected into the growth. If the growth is extensive, devitalization of an area of exposed bone is apt to result. This area can usually be removed as a sequestrum after varying periods of time. In cases where the carcinoma infiltrates the jaw he advocates following the above treatment, together with excision of the jaw as soon as the maximum radium reaction has subsided. He feels that nothing short of total excision is worth while.

In treating the cervical lymph glands he uses a combination of X-ray, radium and surgery. If no nodes are palpable, the case is watched by periodic examinations following irradiation with short wave length X-rays. If a large movable node is present, the X-radiation is supplemented by radium packs and a unilateral dissection of the glands is done with burial of radium emanation in the wound at the time of surgical dissection. If the nodule in the neck is fixed to the adjacent structures, the case is classed as inoperable and is treated by external radiation together with the implantation of radon tubes.

A statistical report of 143 patients shows that 74 are known to be dead and 28 have been lost track of. In 18 cases now under periodic observation, 4 have gone from five to six years; 1, from four to five years; 1, from three to four years; 4, two to three years; 6, one to two years, and 2, six to twelve months. Thirteen cases have not gone far enough to classify.

HOWARD P. DOUB, M.D.

Carcinoma of the Lower Jaw. Douglas Quick. Am. Jour. Surg., December, 1926, p. 360.

A FURTHER STUDY IN NORMAL PYELOGRAMS AND THE VALUE OF BILATERAL SIMULTANEOUS PYELOGRAPHY[1]

By DANIEL N. EISENDRATH, A.B., M.D., and ROBERT A. ARENS, M.D., Urologist and Roentgenologist, respectively, Michael Reese Hospital, CHICAGO, ILLINOIS

AT the 1925 meeting of this Society we[2] directed attention to the many variations in normal pyelograms. We divided those which we had observed into three groups: (*a*) ampullary; (*b*) bifid, and (*c*) a third to which we proposed applying the name "pseudospider," because they resembled closely the "spider" deformity so often seen in pyelograms from cases of renal neoplasm. Since reading this paper we have had the opportunity to verify the convenience of retaining the above three groups.

In to-day's contribution we add some unusual examples of the ampullary and bifid types. We referred briefly in our first paper to the value of bilateral ureteropyelography and described our technic.[2] Since that time we have had abundant opportunity to see the many advantages and test the freedom from danger of such a method. We will refer to these matters later. As a third instructive experience during the past year we wish to call attention to the rôle which is played by contractions of the musculature of the renal pelvis and its calyces and of insufficient distention in the production of apparent deformities even in normal pyelograms. Let us now take these up in the order named.

ADDITIONAL OBSERVATIONS ON THE THREE PREVIOUSLY CITED GROUPS OF NORMAL PYELOGRAMS

1. *Ampullary type.*—This is by far the most common of the three groups or types.

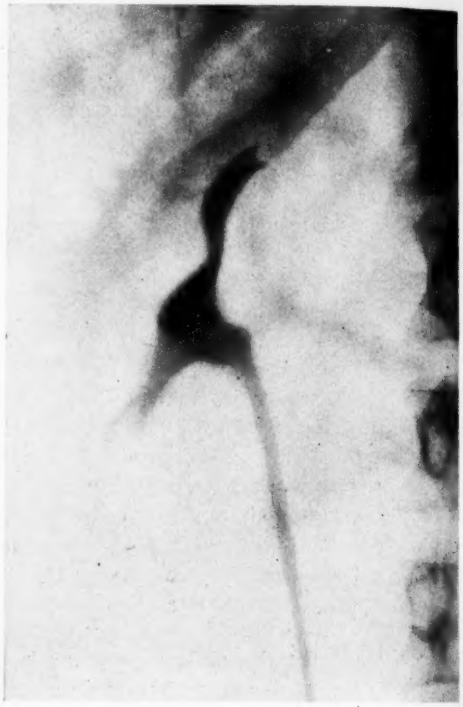

Fig. 1. Unusual normal pyelogram, with rudimentary middle and well-marked superior and inferior major calyces.

One can find all degrees of variation, both in the size of the pelvis proper and in the size, mode of origin, etc., of the major calyces. There may be an almost rudimentary condition of the major calyces, as shown in Figure 1. There may be a difference between the pelves of the two sides, as shown in Figure 2, where one fails to see an inferior major calyx on the right side but can observe a relatively large pelvis proper and a very well developed wide-necked superior major calyx. On the opposite (left) side the pelvis proper and all

[1] Read on November 30, 1926, at the Twelfth Annual Meeting of the Radiological Society of North America, held at Milwaukee.

[2] See RADIOLOGY, June, 1926, p. 474.

Fig. 2. Normal pyelograms showing absence of inferior major calyx on right side and presence of rudimentary middle calyx (arising from superior) on left side.

of the calyces are extremely narrow. In Figure 3 we note the same type of pelvis on both sides, *i.e.*, ampullary with very long major calyces, especially the superior. On the right side the pelvis proper is vertical while on the left side it is almost horizontal.

2. Bifid type.—We have encountered an unusual example of this group, as can be observed in Figure 4. The two chief divisions unite, close to the point of origin of the ureter. The upper pelvis has a well defined superior and a rudimentary inferior major calyx. The lower pelvis has both superior and inferior major calyces and also a rudimentary middle one arising from the superior. One can readily understand such a case by comparison with Figure 6 of our previous paper, in which the evolution of the bifid pelvis from the one with a long superior calyx can be seen.

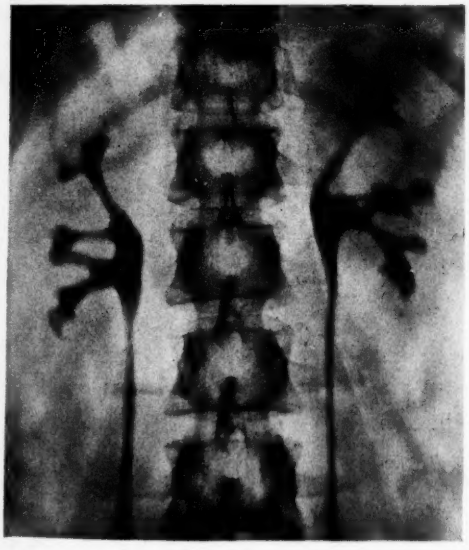

Fig. 3. Normal pyelograms. Note almost vertical pelves proper and long superior major calyces (both sides).

Fig. 4. Unusual normal pyelogram showing almost complete bifidity of pelvis, each half having two major calyces.

3. Pseudospider type.—During the past year we re-examined a patient whose pyelogram, made two years ago, led us to describe the "pseudospider" type. The patient is a woman of sixty who has recurrent

Fig. 5. Same case shown as example of "pseudospider" type of normal pyelogram in previous paper (RADIOLOGY, June, 1926, Fig. 8, p. 478). This pyelogram was made 18 months later and reveals persistence of "pseudospider" type.

attacks of pyuria which were for a time considered to be renal in origin. Recently a communication between the bladder and an old tubovarian abscess was found. The left pyelogram (Fig. 5) of last Spring (1926) reveals a persistence of the "pseudospider" shown in "*A*" of Figure 8 of our first paper. The length of the narrow superior calyx and the peculiar mode of spreading of the lower ones would certainly be puzzling to interpret if the presence of hematuria led to a search for a renal neoplasm.

Fig. 6. Pyelogram from case of left renal infection showing incipient dilatation of calyces in left pyelogram as compared to normal pyelogram on right side.

THE ADVANTAGES OF SIMULTANEOUS BILATERAL URETERO-PYELOGRAPHY

We have examined over one hundred cases by this method without encountering any alarming or even disagreeable symptoms. We believe that the technic described in our previous paper is the safest one. After plain radiography has been completed, we inject the opaque medium (12.5 per cent sodium iodid) simultaneously on both sides through the No. 5 (Pasteau size 10) catheters[3] until a resistance is felt. An exposure on an 11×14 film is then made to include both renal pelves, as seen in Figure 3. One then continues to inject on both sides until both catheters have been completely withdrawn, when a final exposure on a 14×17 film is made. This includes both renal pelves and the entire ureter, as seen in Figure 6. A glance at Figures 6 and 7 will show the great advantages of this method. It

[3]The advantage of using such a relatively small catheter is that any excess of fluid runs alongside into the bladder.

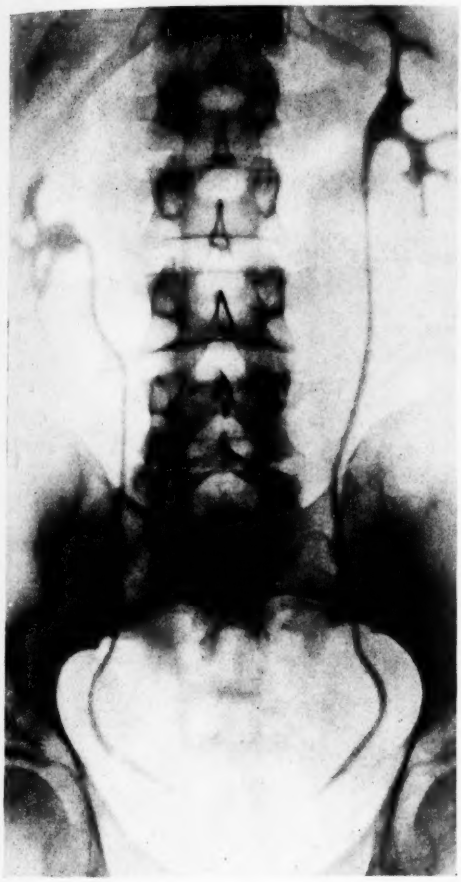

Fig. 7. Bilateral uretero-pyelogram showing normally located and formed left pelvis as compared to "dropped" position on right side. This illustrates the value of bilateral uretero-pyelography.

enables both the urologist and the roentgenologist to observe whether a supposed pathological change in a pyelogram exists on the opposite side. Again, it is of great help in allowing one to judge the degree of dilatation of the pelvis and calyces (Fig. 6), the relative position of the two kidneys (Fig. 7), and whether a deformity—either in the pyelogram or ureterogram—does not show equally as much upon the supposedly normal side. We now employ simultaneous bilateral uretero-pyelography as a routine procedure and can warmly recommend it.

Fig. 8. Normal bilateral pyelograms. Note long superior major calyx on left side and peculiar beaded area in neck of corresponding calyx on right side.

INFLUENCE OF MUSCULAR CONTRACTIONS

Our attention was first called to this factor in causing apparent filling defects and similar distortions, by observation of a number of pyeloscopies at the clinic of Prof. Felix Legueu, in Paris. Radioscopy of the urinary tract has almost completely supplanted a film record. During such a filling of the renal pelvis with opaque solution, one first sees the pelvis proper distend, especially towards its outlet. Then the calyces become visible and from this time on there is a constant flow of the medium from the calyces to the pelvis proper and from here back into the calyces. At one moment the latter are visible and the next they empty their contents through peristaltic muscular movements into the pelvis, and *vice versa*. We have had occasion to observe filling defects of the calyces, especially of their slender necks, which would certainly be interpreted as pathological had an exposure upon a film been made at the moment when such a peristaltic movement was taking place. These

radioscopic observations have taught the writers that one must be on his guard lest poor filling, especially of the calyces, be misinterpreted. We were recently led astray because such a physiologic contraction caused a filling defect. A later pyelogram revealed our error.

We do not believe that pyeloscopy or ureteroscopy will ever become very popular in this country, but we feel that we are able to interpret our films better since we have observed the degree of deformity which muscular spasm can give rise to, both in our pyelograms as in our ureterograms.

Subphrenic abscess.—In a review of over one thousand collected cases the author states that the focus of infection was primary in the stomach in 25 per cent, the appendix in 21 per cent, the biliary tract in 16 per cent, and the duodenum in 5 per cent of the cases. The other abdominal organs and the chest are a focus of infection much less frequently. There is no clear-cut symptomatology. He describes three types. First are cases with an abrupt onset of symptoms typical of an acute abdomen. These cases, after a subsidence of their severe initial symptoms due to localization of the infection, develop a septic temperature with rigors and drenching sweats, rapid loss of weight and strength, and show symptoms and signs referable to the chest. In the thirty-two cases reported there were eleven which gave these findings.

In a second group the symptoms develop insidiously. The patients are usually septic before the onset of the subphrenic involvement and show very little alteration in their clinical course. The abscesses in this class are frequently unsuspected until found by the pathologists. There were thirteen such cases in this series.

In the third series the abscess follows an operative procedure around the subphrenic space. Some may be due to faulty technic but many of them occur in patients with long-standing sepsis, such as liver abscess. There were eight such cases in this series.

Physical examination of the chest and abdomen reveals a dome-shaped elevation of the liver dullness, especially in the mid-axillary line. In those cases with gas in this area, the tympany, shifting with the patient's position, is the most important of percussion signs. Dullness is found posteriorly from the spine of the scapula down. The white count is usually high, with a high polymorphonuclear count.

Roentgenography gives the most important findings. The right leaf of the diaphragm is usually definitely high. Frequently gas is shown below the diaphragm, with often a fluid level which changes with the position of the patient. A lateral examination is essential. The author condemns the use of the exploratory needle as it frequently causes an empyema. In differential diagnosis the greatest difficulties are encountered in differentiating this from thoracic and pulmonary lesions. Liver abscess is also difficult to rule out in some cases. He makes the statement that the X-ray is the most valuable single means of determining the character, site, and size of the lesion.

In the treatment of the condition the author advises incision and drainage of the subphrenic abscess, but this should not be done until there is definite evidence of the presence of an abscess and its position.

HOWARD P. DOUB, M.D.

A Study of Subdiaphragmatic Abscess, with an Analysis of 32 Cases. Allen O. Whipple. Am. Jour. Surg., Jan., 1926, p. 1.

PHYSICAL CHARACTERISTICS AND PHYSIOLOGICAL EFFECTS OF HIGH FREQUENCY CURRENTS[1]

By A. MUTSCHELLER, Ph.D., New York

FOR many years medicine has been an art, but in recent years the influence of physics and chemistry has been so effective that it has assumed more and more the character of a systematic and accurate science; as the result of this the corollaries and methods of the natural sciences should be directly applicable without further discussion and proof. It should thus be permissible to state definitely that all future progress in the application of high frequency currents must depend on further careful coordination of the physical characteristics of the currents and of the biological or physiological effects produced by their application.

INTRODUCTION

That clinical results should be carefully classified and tabulated according to some definite plan and principle is, of course, not a new proposition, but at the present day such a classification should be made on the basis of definite and accurately reproducible physical characteristics of the agent. In the case of high frequency currents we encounter as the first obstacle an antiquated and nondescript terminology which is not understood by modern physicists and engineers and which does not even define and characterize carefully the types and kinds of currents applied as the agents of which the effects are supposed to be investigated and tabulated.

A further obstacle in the solution of this problem consists in the use, by electrotherapists, of high frequency apparatus built empirically, with no particular, definitely stated or indicated purpose; with hardly any exception, the electrical constants and characteristics of high frequency apparatus employed to-day in medicine are generally unknown. The general lack of confidence in this interesting agent in medicine and the many attacks upon it are, therefore, explainable as being due entirely to lack of reliable data and experimental facts.

With this condition in mind, the writer has undertaken to establish certain connections between physical characteristics and physiological effects of high frequency currents, believing, with Thomas Benton Elliot, that "Medicine owes no debt of gratitude to those who teach to her theories without proof."

THE PROBLEM

In a broad sense, there are distinct effects recognized for each of the three fundamental types of current employed in electrotherapy. The direct current, generally designated as galvanic current, is known for its effects of endosmosis and electrolysis through the basic work of physical chemists and physiologists such as Perrin, Freundlich, Martin Fisher and many others. The interrupted or asymmetric alternating types of current of less than 500 impulses frequency, called Faradic current, are known to produce definite effects upon the musculature, and the many works on electro-physiology give full information as to the effects and action of these currents upon the muscular system. Oscillating or high frequency currents have frequencies generally above 1,000 cycles per second, and, in the opinion of most electrotherapists, have just one use in medicine, namely, to produce heat in the tissues. It is generally stated that the heating is produced midway between the electrodes or that the heating is through the tissue; hence, high frequency

[1]Read before the American Electrotherapeutic Association and Affiliated Eastern Societies at the New York Academy of Medicine, January 6, 1926.

currents are named in the electrotherapeutic literature as diathermic, transthermic, electrothermic, etc., currents, with emphasis only upon the *thermic* or heat-generating properties.

While direct and concise reference to other effects produced by high frequency currents, however, seems to be utterly lacking from the literature, the writer has from several sources become aware of the fact that currents produced by different makes or different types of high frequency generating apparatus produce distinctly different effects. Such an impression is, of course, strong inducement for an investigation of the fundamental reasons for the various effects produced, and the results of a search carried out in regular investigating fashion are herewith presented. As many different kinds as possible of high frequency apparatus of which the clinical characteristics are definitely known were tested for variance in their electrical constants, with the idea of determining which factor or factors could be held responsible for the various different effects.

EXPERIMENTAL PART

Eleven different types and makes of high frequency apparatus have been tested. From the clinical results produced they can be roughly divided into two groups; one comprising the apparatus which seems to produce a maximum of local heat, and another, the apparatus which seems to have a somewhat lesser heating effect but to possess important additional properties, particularly upon elimination and the neuro-muscular tonus in general.

Of the electrical factors measured, it seems that the *oscillation frequency* has a comparatively slight effect upon the final results. Frequencies from 100,000 cycles per second to about one and one-quarter million seem not to result in any difference in general physiological effects. Of greater importance seems to be the *oscillation train* or

TABLE I

OBSERVATIONS ON ELEVEN DIFFERENT TYPES AND MAKES OF HIGH FREQUENCY MACHINES

Machine No.	Oscillation Frequency	Spark Frequency	Logarithmic Decrement	Characteristics
3	2,000,000	20	.42	Very general heating effect; the flow of blood is stimulated and the heat is rapidly conveyed and distributed by the blood stream. Arterial tension is in most cases lastingly lowered. Cell function and metabolism are very effectively increased. Elimination of urine, of nitrogen, ethereal sulphates, etc., is distinctly increased. In general, the nitrogen equilibrium is lowered.
11	1,764,000	8	.28	
10	730,000	90	.44	
5	1,280,000	70	.49	
6	1,480,000	80	.58	Effects intermediate between those of Group 1 and Group 2. Heating is rather general and elimination is generally augmented.
7	1,100,000	70	.52	
1	1,190,000	50	.80	
9	1,000,000	110	.89	
8	1,666,000	45	1.01	Heating is well localized and local temperature rises highest. Arterial relaxation, assuaging and quieting effects are very pronounced. Considerably increased products of cell chemistry, but not so much of muscular activity. All effects are distinctly localized.
4	2,000,000	20	1.01	
2	896,000	50	1.41	

Oscillation frequencies and logarithmic decrements were measured with a standard wave meter in the usual manner. Spark or train frequencies were determined by counting the glow lines by a synchronously rotating neon glower tube connected into the oscillating circuit. For laboratory reports see Steel, *Am. Jour. Electrotherap. and Rad.*, 1916.

spark frequency, and such apparatus as is free of harmonics or superimposed low frequency waves produces no Faradic or irritating effect unless less than about two hundred forty sparks pass per second. Increasing the sparking frequency seems to increase the heating effect and to decrease somewhat the effects upon the neuro-muscular and eliminatory systems.

Considering the *logarithmic decrement* as a basis it might be advantageous to make three groups: (1) The group comprising those currents which produce practically only heat, with its accompanying assuaging, soothing and chemistry-accelerating effects, having a decrement larger than 1.0; (2) an intermediate group having decrements between 0.5 and 1.0, which combine the effects of the first and third groups; (3) the last group, comprising those currents whose damping factor or logarithmic decrement is smaller than 0.5, and which produce pronounced effects other than heating.

Explanatory Facts. The meaning of the term "decrement" can be illustrated briefly as follows: When the switch of a high frequency machine is closed, then energy flows into the condenser until the voltage across the condenser has risen to the point at which it is capable of jumping over the spark gap connected in parallel with it. The gap then performs the function of a switch, for, while the spark passes, the gap or switch is closed. While the gap is thus closed, the energy stored in the condenser flows back, and if the resistance in the circuit is not too great the current pendels back and forth like any vibrating object in a manner with which everyone is familiar. Now the number of swings or vibrations in one second of time is known as the "oscillation frequency" and in the ordinary type high frequency machines it is from 500,000 to about two million impulses per second. It must, however, be stated that the swinging is not continuous but that it lasts only a very short period of time, for the energy which has stored in the condenser will soon be spent and dissipated. Then a new spark will pass and the same thing will take place over again. Therefore, each spark produces one oscillation train and we have to distinguish clearly between oscillation and spark or train frequency.

Now, it has before been indicated that the oscillation train lasts only a very short period of time and that its energy is dissipated and spent, but what happens to that energy? It is transformed either into heat or into *something else,* and it is this "something else" in which we are interested at this particular moment and which, therefore, we shall have to investigate.

First of all, an oscillation train may die out rapidly or slowly, according to conditions. The measure of its rate of dying out is the decrement or damping factor; if the oscillation train dies out rapidly, the decrement is numerically large, and if the oscillations persist for a long period of time, the numerical value of the decrement is small.

The oscillations employed in radio-telegraphy are always so controlled that their decrement is small—never larger than 0.2 This is because of the fact that, if the decrement were larger, then the waves would not travel a great distance and would be very weak, for in that case nearly all of the energy is dissipated in heating the circuit and the antenna.

In medical high frequency machines there exist naturally very similar conditions. If the damping factor is large, then all the energy in the oscillating circuit is consumed and dissipated as heat. If, however, the damping factor is made considerably smaller, then, as in the case of radio waves, there is something else produced which, as the clinical results indicate, consists in effects upon the cells, probably of a vibratory nature, through which the internal cell function and cell activity in general is visibly and effectively increased. By then also adjusting properly the oscillation train or

spark frequency (and also the oscillation frequency), it is possible to produce either a maximum of heating effect or a maximum effect upon cell function, cell metabolism and elimination in general.

DISCUSSION

With the recognition of the above mentioned facts, it is possible to explain many clinical observations which hitherto have been used empirically or which have been set aside as being in conflict with fundamental laws. But if we consider cells as being acted upon through their vibratory response to the oscillations, much the same as any elastic object can vibrate in resonance with the frequency of an impressed force, we can then think of the effects of slightly damped high frequency currents as setting the cell into vibration. Through this vibration its own internal chemical and eliminatory function is naturally increased and a vibration is also transmitted to surrounding interstitial tissue, thus readily explaining many peculiar observations.

It is, for instance, found that one type of current produced by one machine does not heat as much as another, although the same number of milliamperes are applied under like conditions. But if cell vibration, stimulation and circulation are absent, then the heat produced remains localized, with the necessary result that the part of the body so treated will rise in temperature to a considerable degree, although a comparatively small current is applied. Moreover, if the same milliamperage of a slightly damped current is applied to the same part, and thereby the cell function, circulation and perivascular vibrations are increased, then naturally the heat produced in the tissue is conveyed to other parts of the body and the heat locally accumulated is less, with the result that the temperature produced is lower.

Again, it has been reported by a number of clinicians that certain chronic conditions, such as appendicitis, can be treated successfully with a machine which is found to have a particularly low damping factor, with the disappearance of the symptoms, whereas, if treated with another machine, found to have a large damping factor, the condition becomes toxic, acute and distinctly worse. Evidently in a case of congestion and inflammation, the production of heat alone, without causing a breaking up of the congestion and a rapid removal of the congestion products, is sufficient to produce a localized, toxic and acute condition. In the other case, however, the breaking up of the congestion without stimulating further the already existing inflammation, seems to be helpful in re-establishing normal physiological function.

The logarithmic decrement or damping factor alone, however, seems not to be the only factor determining whether the cells remain in a quiescent state and are then mainly heated, or whether they enter into a vibratory function which seems to be the cause of the increased effects of cell activity. It would *a priori* follow that a cell in order to vibrate to a satisfactory extent should be acted upon by a force vibrating at such rhythm that the cell or other organ can vibrate according to its own natural vibration frequency.[2]

It can be easily determined by experiments that if the spark or oscillation frequency is adjusted so that there are between about two hundred forty and five hundred sparks per second, then the effect of the treatment is particularly stimulating upon the muscles and blood vessels. The indications are a marked increase in the elimination of products and high urine density, which characterize muscular activity. The

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[2]We are all familiar with the experiment that in order to make a bridge vibrate, it is necessary to jump on or march over it at a certain definite rhythm. Jumping or walking either faster or slower does not cause the bridge to vibrate. Again, to receive at maximum strength a radio signal, it is necessary to adjust the receiving set so that its own natural vibration frequency is the same as that of the incoming signal. Such conditions are known as "resonance conditions" and they are utilized very extensively to produce vibrations of any kind.

fact that toxic conditions generally are not produced is undoubtedly due to the very effective elimination of waste products, and the distinct lowering of arterial tension indicates that the eliminatory function in particular has been stimulated. If, on the other hand, there are a larger number of spark discharges, say, around three thousand per second, then the effects are of a different kind and marked by a lesser degree of elimination and consequent localization of the effects upon the treated area.

The logical deduction from these considerations would be that if any kind of cellular or tissue congestion exists, then the use of a current having a small damping factor and a small number of discharges would most effectively and most promptly result in a disappearance of this congestion and of an increase of circulation and normal functioning. On the other hand, a strongly damped oscillation current, with a larger number of spark discharges per second, would be particularly effective in raising the temperature in one limited part of the body, and would then be peculiarly suited for the localized treatment of infections, particularly those due to organisms distinctly thermosensitive and of which the lethal temperature can be easily reached without injury to the tissue. Such organisms are, in particular, the pneumococcus and the gonococcus. The conditions above indicated have in recent times been very effectively treated through the therapy of high frequency currents.[3]

A somewhat greater significance has been given recently to the oscillation frequency through the work of the physical laboratory of the Cleveland Clinic, by which it became established, as Fricke showed, that the cell resistance decreases rapidly at frequency above one hundred thousand cycles down to a minimum at ten million cycles per second. A physical interpretation of this fact would be that cells representing small capacities cause a current of low frequency to pass around the cell through the interstitial tissues, not through the cell, while a current of higher frequency—up to ten million cycles—passes directly through the cell and the nucleus, in which case naturally there can be expected a much greater effect upon the rate of cell metabolism and cell function.

[3]It does seem incorrect to designate all high frequency currents as diathermic, etc., currents, although a current with a rather large damping factor and a high spark frequency would constitute specifically a diathermic current. A high frequency current with a small damping factor and a low spark frequency, however, could not logically be designated by the same term.

SUMMARY

It has been shown in this paper that—

(1) The observations of clinicians to the effect that different types and makes of high frequency machines produce different physiological results find a full explanation in the differences of the logarithmic decrement or damping factor of the currents.

(2) The oscillation train or spark frequency also has a decided selective effect upon the magnitude of the cell or organism acted upon, in that it, according to the principle of resonance, can be adjusted to the natural vibration frequency either of a specific protoplasmic cell or a particular muscular organ.

(3) It has been pointed out that the oscillation frequency up to one hundred thousand cycles is not at all a factor of importance, but that at higher frequencies the cell conductance increases.

(4) It has been postulated that large decrements and large spark frequncy currents (diathermic currents) are particularly useful for the production of localized heat and, therefore, for the destruction of infectious organisms whose lethal temperature can be reached without injury to the tissue.

(5) It has also been pointed out that a high frequency current of low decrement and low spark frequency is particularly effective in increasing the function of the

cells and small organs, which leads to the result of lowering the arterial tension, releasing congestion, and increasing the production of secretion from and supply to the cells.

(6) It is suggested that the old nomenclature be discarded in favor of physical engineering terms which are fully descriptive and well defined and which constitute a terminology readily understood by physicists and physiologists. Such a terminology would facilitate that co-operation and mutual understanding between physicists and biologists upon which all future progress in this field depends.

Radium therapy in dermatology.—The author gives the results of six years' experience with the use of radium in the treatment of skin diseases. Warts, especially papillomata of the face and hand, yield readily to radium. Pain and discomfort from corns are relieved. Itching and pain of keloids can usually be alleviated, and partial retrogression brought about. Radium has proven of great value in lupus erythematosus. Lupus vulgaris does not respond well.

Care in the selection of cases of nevi, and in the manner of exhibiting radium, has brought extremely satisfactory results. The capillary and cavernous types respond favorably, while port wine stains and the pigmented variety do not yield with equal satisfaction.

Pre-cancerous lesions of the skin and mucous membranes, such as leukoplakia, senile keratoses, chronic seborrhea, cracks, fissures, or warty excrescences clear up readily under radium.

In rodent ulcer, radium should be the treatment of choice, but in the squamous type of cancer, and in all cases where bone or cartilage is involved, surgery offers best results.

L. J. CARTER, M.D.

Radium in Dermatology. Hugh Mackay. Can. Med. Assn. Jour., November, 1926, p. 1352.

Radiochemical treatment of inoperable neoplasms.—The author reports 741 cases of malignant tumors which were treated with roentgen rays and intravenous injections of 10 per cent cholin boric acid solution. The following-up was possible on only 200 patients. Werner has the impression that the combined therapy offers better results than roentgen rays alone.

E. A. POHLE, M.D.

On the Results of the Radiochemical Treatment of Inoperable Malignant Neoplasms in Man. R. Werner. Strahlentherapie, 1926, XXIV, 153.

Protection in X-ray laboratories.—The author states, rightfully, that the protection in many laboratories is by no means ideal. He suggests that the personnel might carry films in order to find out if the tolerance dose (Mutscheller-Glocker) is not over-reached. Various ways to improve present conditions (more lead in the walls, smaller and thicker lead glass windows, lead cylinders for tubes) are discussed.

E. A. POHLE, M.D.

Regarding the Protection against Radiation and its Improvement. Th. Neeff. Strahlentherapie, 1926, XXIV, 161.

DISCUSSIONS

DISCUSSION OF PAPER READ BY DR. I. S. TROSTLER ON "THE MALPRACTICE INSURANCE QUESTION"

Annual Meeting of the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926. The paper was published in RADIOLOGY *January, 1927, p. 14.*

DR. R. H. STEVENS (Detroit): I am very glad that Dr. Trostler has presented this matter in the way he has and so clearly. The subject is one of importance to all of us. We all have a natural feeling of resentment, I think, when we have to pay out money to protect ourselves from unjust and unfair prosecution and persecution on the part of those whom we try to help. But you know life is one great struggle, and it is only by sacrifices that the fittest are able to survive, and these are the prices we have to pay for our existence. There was a feeling of resentment when the insurance company jumped its premiums from twenty-five to over four hundred dollars, in my own case, without warning. When that happened I looked about to see what could be done in order to secure adequate insurance in some other concern. I even considered the matter of a mutual insurance—say, among our own radiological people—because I thought there was very unjust discrimination against radiologists. I took this matter up with a number and with the insurance companies, including one Dr. Trostler mentions, and investigated the matter pretty thoroughly. I finally came to the conclusion that the only thing to do was to pay the price and secure reliable and really protective insurance.

Dr. Trostler has explained to us what the results from insurance in these mutual reciprocal companies are. He has brought that out so clearly that I do not need to say anything further about it. One point that he has mentioned is, What can we do to decrease our rates? I think that depends upon ourselves. First of all, we must be very particular and careful about the opinions we give out about some one else's work. I believe that sometimes we are a little thoughtless, when, with more care, we might save a serious suit against one of our fellow radiologists. In the next place, a further development of our Registry of Technicians would be a great help. If we could provide suitable examinations for technicians, have them registered and under an official body that would be recognized, it ought to carry some weight in a trial against a man for malpractice if an injury occurred while a patient was being treated or examined by a technician. Of course, we are directly responsible for our technicians, but if we employ those who are themselves responsible and have had good training, surely that ought to have some influence in our favor with a jury. Again, as Dr. Trostler said, we might have some official body which would register roentgenologists. It seems to me that this is a subject which the College of Radiology might well take up, and that roentgenologists who are members of the leading roentgenological societies might in some way be classified as competent, and that ought to have influence in the decision of these cases.

DR. I. SETH HIRSCH (New York): I cannot refrain from taking part in this discussion, because the matter is of such importance to all of us, since there are not many men doing X-ray therapy who have not had a more or less unpleasant experience arising out of a malpractice suit. If there is a fortunate brother who has escaped until now, to-morrow may bring him the experience.

There are several points I want to make: In the first place, as Dr. Stevens has pointed out, it is essential that the therapist be thoroughly qualified. There is in medicine no form of treatment which requires greater skill, a wider or more varied scientific knowledge or more careful and painstaking effort than does radiation therapy, whether applied to superficial or deep lesions. The patient's viewpoint must be considered in this matter. He has a right to feel that when radiation therapy is

applied, it is done by one who by virtue of special training and special skill is competent to do so. We understand that more qualifications than the mere possession of appliances for administering this form of therapy are necessary. I am sorry to say, the general profession does not always bear this in mind.

But malpractice suits are as often brought against men who know their business and know it well, as otherwise. This is due to several causes: One of the important reasons arises out of the loose, unscientific language used by the profession. The term "X-ray burn" should have no existence in medical literature. (Applause.) It is used in our discussions and written in our literature. Not only is it unscientifically incorrect, but it serves to arouse in the mind of the lay person the suspicion of neglect. The profession should be made to see the jeopardy in which this places the radiologist.

It is often necessary to produce a skin erythema to accomplish the desired result and much trouble has been caused by the patient being told that such a reaction was a burn. The longer I do therapy the more I am convinced that a dose of radiation cannot be given to the human skin without changing that skin once and forever. The surgeon does an operation and leaves a scar; when he drains, perhaps a bad scar. The radiation therapist who gives a dose of radiation, leaves a skin which (particularly when he has accomplished the results he set out to accomplish—the cure of the disease) may after a period of three, four, five or even seven years show atrophic and degenerative changes. The radiologist is then blamed for having done something wrong. Telangiectasis and atrophy are X-ray scars and should be so understood by the layman, and particularly by the profession. We have as yet no means of preventing such after-results. This also should be made clear to the profession and the laity.

Dr. Byron H. Jackson (Scranton, Penn.): There have been two things brought out in the discussion in which I am particularly interested. One is the registration of radiological technicians. We listen to some of the things said here and go home and forget them. I want to impress on you the importance of having the radiological technicians registered. Suppose you were sued in one of these cases where a change has taken place in the skin, as it always does, and you were brought into court and it was found that your technician did that work. One of the first and most important things to you is to know that he or she is registered, because the Court may say, "What authority have you for giving this treatment?" One of the best reasons he can give is that he is already registered, and the radiologists have recognized that persons so registered are able to give this treatment under medical supervision.

Another thing has been brought to my mind by Dr. Hirsch, and we all have had this in mind. Many times a patient will say: "Now, Doctor, I have objected to having an X-ray treatment because I am afraid of an X-ray burn." Of course, as Dr. Hirsch says, we ought never to use that term "burn" because it is not a *burn*. We say, "Oh, the X-ray is perfectly harmless; we will be able to cure you, there is no doubt about that." Now, the X-ray is not perfectly harmless; it is absolutely dangerous, and because it is a dangerous and destructive method they come to you that you may destroy their lesions. Why don't you say, "It is a dangerous method and I do not want you to go away from here and think that this is not dangerous. We will cure this lesion, but we will leave a scar; there is no doubt of it."

Dr. F. B. Sheldon (Stockton, Calif.): For a number of years I have been very much interested in this subject of malpractice insurance. I have taken it up with the general agents of the insurance companies, and they tell me that when a man does less than half of his work—that is, half of his time—with X-ray, he can get his insurance for the rate of the general practitioner, but when he goes over that half, then his rate is stepped up five hundred to a thousand and maybe two thousand per cent. It seems to me that they thus put a premium on ignorance. In the region in which I have been working, there have been no serious suits except against those persons who were not doing full-time radiological work:

the suits have all been against those who were doing part-time work. Agents also tell me that some of the men pay 500 per cent more than the general practitioner when they are doing nothing but radiographic work—no therapy whatever. It seems to me that the rating of roentgenologists by this Society ought to help us in the matter of our insurance premiums. I think it is a good idea, and if we will talk that to all the agents, to all the insurance companies, it may help us in the reduction of our premiums.

DR. TROSTLER (closing): I want to thank those who have discussed my paper.

This matter of the classification of radiologists should not, in my opinion, come up before any other body of radiologists than the Radiological Society. We are the largest and strongest in every way of any of the roentgen organizations, and logically the body to take up the question with the insurance companies. I intend to bring up the matter of the President appointing a committee at the next business session to take up this question with the insurance organizations. What we want to know is, Will a classification of radiologists by an official committee or council from this Society make any difference in the rates for our insurance against malpractice suits?

Dr. Hirsch is right, as usual, in regard to the term "X-ray burn." It has been my privilege to appear on the witness stand occasionally, to try to help out some of our colleagues who have malpractice cases. In a recent case in Ottumwa, Iowa, I insisted that the term "X-ray burn" had originated in the mind of a lawyer; that as physicians we did not recognize the condition as a burn; that we called it what it was, an inflammation of the skin or dermatitis. The lawyers tried to corner me and get me to admit that it was a burn, and though I was on the witness stand several hours, I do not believe that they got me to contradict myself or compromise the defendant's case very much. I felt that I had materially helped to secure the "verdict for the defendant" that the jury rendered.

The registration of our technicians, as brought up by Dr. Byron Jackson, is in my opinion an extremely important one. If when sued, and on the witness stand, the defendant can testify that, if he did not operate the machine himself, his technician or assistant who did do so was registered in the "Technician's Bureau" of the Radiological Society of North America, he will have gone a long way toward proving that he has not been negligent, and that he has used due care and diligence as well as the necessary skill in the application of his therapy. That is one of the most important things in defending a suit.

I have repeatedly stated before this Society that one of the most important points in defending X-ray dermatitis cases is that you (or the defendant) shall have *good records.* Let me advise you again to *make carefully written records of every time you close the switch* (or have it closed for you) *on a therapy case. Write it down! Do not wait until to-morrow or next week or even for fifteen minutes, but write it down either before the switch is thrown or while the treatment is in progress.* If that is done, you are in a position to testify as to what your technic was in an absolutely certain manner, and if your record was made at the time of administration of treatment, there is every reason for the jury to believe you. Eminent jurists acknowledge that written records of anything are the best evidence that what was written was done. If you have to rely upon your memory, there is a chance for error, but *if written records are at hand you know and the jury will know that you know exactly what happened and how it happened.*

DISCUSSION OF PAPER BY H. P. DOUB, M.D., A. BOLLIGER, PH.D., AND F. W. HARTMAN, M.D., ON "THE RELATIVE SENSITIVITY OF THE KIDNEY TO IRRADIATION"

Radiology, February, 1927, p. 142.

DR. B. H. ORNDOFF (Chicago): This paper is fundamental and I think it is a very valuable contribution to the science of radiology. It is this class of work, developing data of a positive character and upon which clinical deductions may be made, that constitutes a real foundation for future medicine and the science of radiology.

There can scarcely be a more important subject than tissue reaction to irradiation. Dr. Doub has pointed out the local tissue reaction, the organic response as well as systemic changes in general. He has also pointed out the importance of functional as well as structural reactions to radiation. This is rapidly becoming a large field in the practice of medicine.

It was my good fortune to be associated with Dr. Andrew C. Ivy, in Chicago, in an attempt to show some of the effects of irradiation on glandular secretions. A subcutaneous transplant of the pancreas showed stimulation with small doses and almost complete depression with as much as one human erythema dose. This depression lasted for more than forty days and only 50 per cent of the transplants have later returned to normal.

There is little doubt but that radiotherapy is a potential therapeutic agent; what remains for us is to establish its clinical value.

DR. DOUB (closing): I wish to say a few words in explanation of this work, as a number of people have asked me in regard to this. I would say, in the first place, that we started this work not in an attempt to show what damage would be done to the kidneys from irradiation, but to find a method to produce nephritis in order to study it clinically. In regard to kidney damage from deep X-ray therapy, it is my personal opinion that in cases which show some reduction in function of the kidneys, as in early nephritis, it will very likely be made worse by a large dose of deep X-ray therapy over this region. I do not believe that in the ordinary normal case a moderate degree erythema dose over the kidney will cause any great damage, but I do believe that a large dose in excess of what is ordinarily called a mild erythema dose, will cause damage. Neither of the cases I reported was treated by me, but came into the hospital later because of symptoms they had, and we were able to check back and find the exact dosage they had received. From the large number of cases treated over this area, and from the very few nephritic cases reported, I do not believe there is any very great danger except in those cases which have some reduction in renal function.

Integrating roentgen dosimeter.—This ionization instrument called "Mekapion" permits the measurement of the total dose given during any time interval. It is a rather complicated apparatus using an amplifying tube and an electrical timing device. Between 150 and 200 K.V., the chamber is independent from the wave length. For details of the construction, the reader is referred to the original article.

E. A. POHLE, M.D.

The "Mekapion," an Integrating Roentgen Dosimeter with Autocontrol. S. Strauss. Strahlentherapie, 1926, XXIV, 348.

CASE REPORTS AND NEW DEVICES

EXAMINATION OF THE MASTOIDS BY USING A SERIAL PLATE CHANGER

By S. W. DONALDSON, M.D.,
St. Joseph's Mercy Hospital, ANN ARBOR, MICHIGAN

The radiologist accustomed to using the 23° angle technic for examination of the mastoids, stereoscopically, and in all cases obtaining films of the opposite side for comparison, has in all probability noticed that—

(*a*) Several mastoid examinations together practically fill the developer tank with film hangers.

(*b*) Most of the 8 × 10 hangers are in use while films are drying.

(*c*) Sorting, numbering, labeling and filing a large number of films of the same part are liable to occasion error.

(*d*) Four films in stereoscope viewing boxes fold and buckle unless clamped together.

The routine method now in use at this hospital apparently relieves these difficulties and at the same time lowers the initial cost of the examination in respect to films.

THE PROCEDURE

A gastric serial plate changer (Fig. 1) is

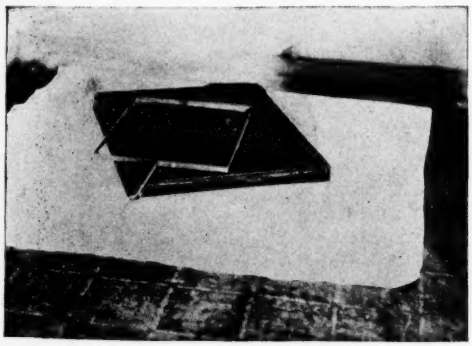

Fig. 1. Gastric serial plate changer (as introduced by Dr. Pirie) and rack for shifting 11 × 14 cassette.

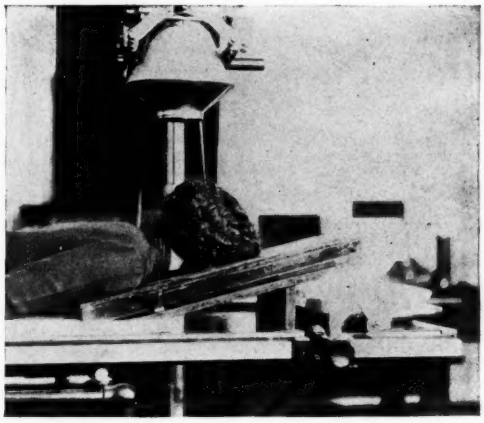

Fig. 2. Plate changer tunnel on an angle board with patient in position for examination of mastoids.

set upon the angle board and the ear of the patient placed over the aperture (Fig. 2).

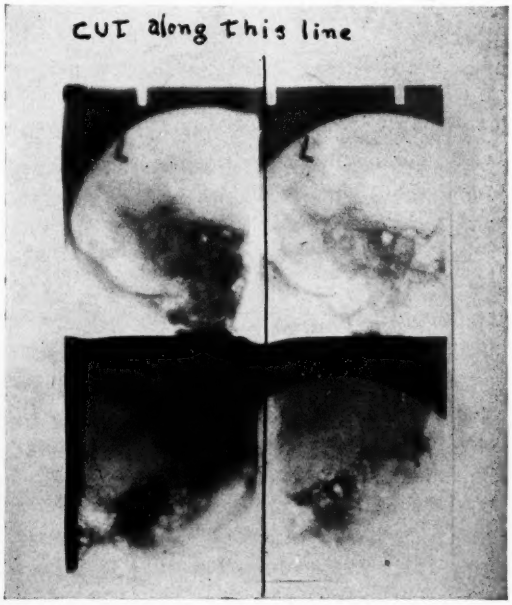

Fig. 3. One 11 × 14 film showing four exposures of mastoids. This film is cut through the length of the 14-inch dimension to obtain the stereoscopic set.

After each exposure the cassette is shifted with the stereoscopic shift of the tube. This uses the lower half of an 11 × 14 film. The opposite ear is then placed in the same position and the upper half of the film exposed by the same method. This gives four 5 × 7 exposed areas on one film.

When the film is dry it is then cut (Fig. 3) so that one right ear and one left ear is on either end of the strpi. When set up in the stereoscope both mastoids can be studied and compared with more ease than when separate films are used.

EASY METHOD FOR MAKING SURFACE CASTS TO HOLD RADIUM TUBES IN POSITION

By WILLIAM H. CAMERON, M.D.,
PITTSBURGH, PA.

Through the kindness of Mr. Robert M. Kerr, of the Detroit Dental Manufacturing Company, Detroit, I have secured powdered molding compound which I incorporate in gauze strips (exactly as one would do with plaster-of-Paris), heat slightly over a hot plate, and mold to parts. The number of strips used depends upon the thickness desired, or, rather, the distance the radium tube is to be held away from the surface of the lesion or from the skin surface. If, however, the distance is more than one-quarter of an inch, I usually build up the casts at the point or points where the radium tube is to be placed; otherwise, it would prove cumbersome and heavy.

This makes a light, strong cast, serves to hold radium tubes in exact position, particularly over irregular surfaces, and does away with the use of adhesive plaster over the seat of radiation. It has an advantage over ordinary molding compound in that it becomes hard quicker, will not stick to hairy parts, is not brittle, and when radium tubes are to be moved to different locations, these locations may be plainly marked on the cast and the tube moved without much difficulty.

This method cannot, however, be used in mouth work.

MEDIASTINAL TERATOMA

CASE REPORT

By HOMER W. GRIMM, B.S., M.D.,
PITTSBURGH, PA.

I can find no other case recorded in which there has been found a teratoma of the intrapericardial region. This occurred in a child three months old, referred to me for X-ray diagnosis. The provisional diagnosis was "idiopathic hypertrophy of the heart."

Antero-posterior and lateral films (Figs. 1 and 2) of this case showed a large tumor that completely obliterated the outline of the heart and was located largely in the anterior portion of the chest involving the mediastinum. The X-ray examination was made December 16, 1925, and the child died on December 20, 1925.

Following is a report of the autopsy find-

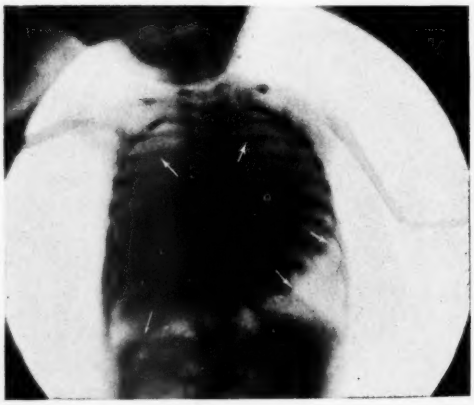

Fig. 1. Antero-posterior view, showing tumor that completely obliterated the outline of the heart and was located largely in the anterior portion of the chest involving the mediastinum.

ings as made by Dr. J. W. McMeans, of Pittsburgh. He will also report this case in another journal from a pathological standpoint.

There was a broad fluctuating tumor

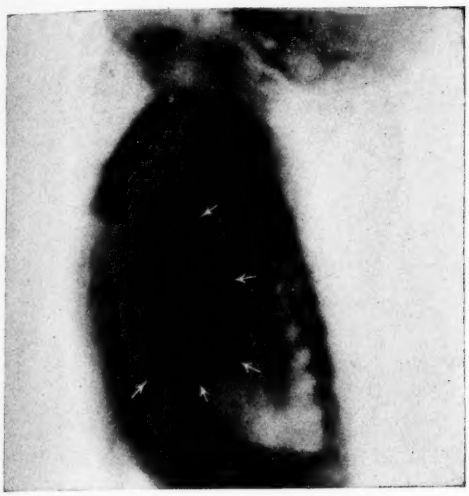

Fig. 2. Lateral view of tumor shown in Figure 1.

which filled the entire anterior aspect of the chest, both lungs being pushed posteriorly. The mass had a thin membrane as a wall and appeared milky in color. Inside the mass a light colored lipoid fluid was found. The heart was inside the mass and measured $5 \times 4 \times 3\frac{1}{2}$ cm., being of normal size, shape and position. There was an intimate association between the adventitia of the great vessels and the mass. The mass was lobulated with small orange-sized growths of semicystic consistency. There were numerous pea-sized cystic compartments.

On section, there were found to be multiloculated cysts, with islets of homogeneous tissue. In some of the cysts there was a semisolid material that looked like parboiled tapioca. In others a brain-like substance was found.

A bacterial examination of a dark brown fluid did not show any growth.

A microscopic examination of the tumor revealed the following types of tissue: a large amount of gilial structure predominating, also choroid plexus, skin, sebaceous glands, sweat glands, muscle, mucous glands, cartilage, intestinal tract, and hair follicles.

The pericardium was milk-like in color but smooth and glistening. The heart structure was apparently normal.

The lungs were healthy except partially collapsed, some edema and passive congestion. The mediastinum and glands about the hilus of the lungs did not show any growth.

A SIMPLE METHOD FOR KNOWING THE FACE OF A PLATE TAKEN IN A CASSETTE

By THOMAS D. CANTRELL, M.D.,
BLOOMINGTON, ILL.

Since the advent of the double-coated film we have all of us been many times embarrassed in judging the face of our film, being unable to tell the right and left of many films taken. I, myself, have been embarrassed in court in determining which way a film was taken. In order to overcome that I had a stamp made of my name and address, just the opposite from the ordinary stamp, the impression from it reading backwards. With the cassette lid up and face down, I stamp on the front intensifying screen my name and address, which, of course, reads backwards. Then on placing the film in the cassette and shooting through the face of the cassette, my name becomes clearly inscribed on the film simply because I have put that much of the intensifying screen out of commission. The name and address appear on the film permanently after development and one knows when they read properly that he is looking at the face of the film.

Fig. 1, showing the stamp reading backwards.

As every cassette in the office is stamped it is impossible by omission or otherwise to be mistaken as to the front of the film. The marking shows only when the plate is being examined before the ordinary diffused light; therefore it is quite modest and does not act as an advertisement on the film. Black indelible ink is used.

Fig. 2. A film stamped in such a way that the face of it may readily be determined.

Metastasis in prostatic carcinoma.—Only three articles in the last eight years have dealt with metastasis in carcinoma of the prostate. Quotations from statistics by Bumpus show that of 228 patients with this condition who were examined by X-rays, 69 showed metastasis: 46 in the pelvis, 40 in the spine, 8 in the lungs, 8 in the ribs and 7 in the femurs. Metastasis in carcinoma of the prostate is a disease of bone destruction with new bone formation; the destructive process is slow, accounting for the description of areas of decreased density, surrounded by areas of increased density.

The hyperplastic bone production resembles Paget's disease, which may have to be differentiated. In Paget's disease of the spine, the bodies of the lumbar vertebræ are widened and flattened, while malignancy produces little, if any, change in the shape. The skull in Paget's disease shows characteristic thickening and density of the inner table, finely porous outer table with nodules over the vault. The negative skull may be an aid in a differential diagnosis.

A case report with excellent illustrations is given. The late metastases involved all the pelvic bones, heads and upper parts of the shafts of the femurs; all the bodies of the lumbar spine; nearly all of the ribs; clavicles; scapulæ; humeri-heads and upper shaft, and thoracic spine, while the skull was not involved.

TRESSA R. MORAN, M.D.

Metastasis in Carcinoma of the Prostate, with Report of a Case Showing Early and Late Changes. John Sproull. *Am. Jour. Roentgenol. and Rad. Ther., December, 1926, p. 565.*

EDITORIAL

THE FUNCTION OF THE LOCAL ROENTGEN SOCIETY[1]

One of the pleasant chapters in my early studies in roentgenology is written around the "Triangle." The Triangle was a small society composed of three members, Dr. Vernon J. Willy, who lived in Ann Arbor, Mr. Harry Dachtler, who lived in Toledo, and the speaker, at that time a resident of Detroit. We formed by mutual agreement a little society which had meetings once a month, usually on a Sunday morning. One month we would meet in Ann Arbor, the next month in Toledo, the third month in Detroit, and then we would go around the triangle again. These little informal meetings which were kept up until Dr. Willy was called to Rochester, Minnesota, were always a source of considerable pleasure and certainly of much profit. I remember that Dr. Willy at one meeting demonstrated the principle and operation of the autotransformer control, which was long after rediscovered by the manufacturers. In this intimate association we learned much from each other in the discussions of our mutual problems. In recalling the benefit which we derived from this little society, it suggested itself that possibly it might be well to discuss for a few minutes the function of the small roentgen society.

The national societies, with their big membership and their wonderful papers, are a source of inspiration to all who attend their meetings and to the many who read their published transactions. The scientific exhibits, commercial exhibits, and the elaborate programs all combine to afford wonderful educational opportunities. When we attend the annual meeting of the American Medical Association, we wonder at the organization which can put on such remarkable sectional programs and stage such convincing and wonderful exhibits, but if we stop to consider for a moment, we will realize that the county medical society is the backbone of the American Medical Association. The work of the annual meeting is an inspiration for the members to continue their enthusiasm and to work in the smaller county societies. It is these county society meetings, many of them necessarily small, attended by the bulk of the profession, which constitute the real educational features of the organization.

So it is in radiology. Our national meetings serve a most wonderful purpose. It is a great privilege to attend them, and in going away after a meeting, we are fired with zeal to go on with our studies and to do better work. On returning home, therefore, one should find the opportunity for attending at least one meeting a month with kindred spirits.

One may perhaps ask, "How small can one of these societies be?" Judging from the personal standpoint, I would answer that two members are sufficient to carry on an interesting meeting; more, of course, would be better. Enthusiasm will go far to make up for lack of numbers. One of the striking benefits which result from the meetings of these small societies is the further cultivation of friendship by getting better acquainted with one's co-workers, or

[1]Speech delivered before the Radiological Society of North America upon the occasion of the annual banquet, December 2, 1926.

perhaps we may say with one's competitors. Owing to these frequent contacts, there will be fewer misunderstandings and fewer backbiting criticisms. Our fellow-men, as we get to know them, reveal many fine traits of character which are often concealed to the casual acquaintance.

It is always a treat to discuss the mooted points of diagnosis and technic with those who are equally interested. The smaller the group, the freer the discussion. In a large meeting, many of the auditors are prevented from asking questions and contributing, either from diffidence or on account of what may be termed an inferiority complex.

The small local society in some of its meetings may take on the aspect of a journal club, in which the members may present more or less comprehensive reviews of important articles. While the abstracts in our own special journals are most useful, yet they are often merely suggestive of the subject matter, and frequently a more exhaustive review is desirable. The program committee of such a small society need never be at a loss for topics. The secretary can always announce that there will be a presentation of interesting cases, and, as the members become habituated to bringing in their recent striking films, a round-table discussion will ensue which oftentimes makes a more interesting and instructive session than the presentation of a written, formal paper.

It is probably true that no class of medical workers have more mutual kindly feelings than radiologists. Accordingly it will not be hard occasionally to secure a non-resident speaker, whose contributions will be gratefully received. Meetings can from time to time be arranged with men in other specialties, so that the radiologist can get the viewpoint of the surgeon, the pediatrician, the orthopedist, the dentist, and others. This getting the other man's viewpoint is of tremendous value and will be of mutual advantage.

One often hears the criticism that we have too many meetings. I grant that. We have plenty of meetings which cost too much time and too much money. The newly elected officers of a large society are always desirous of staging a program which will equal or surpass any put on by their predecessors. This is always a laudable ambition when it is a question of an annual meeting of a large society. This criticism does not apply to small societies.

It is interesting to note the realization of this type of meeting in some of the larger cities. The Chicago Roentgen Society, the Philadelphia, the New York, the Detroit, and many others, with their monthly meetings, are a source of inspiration and education to their numerous members. The groups are not unwieldy, the frequency of their meetings is not burdensome, and the personal contacts are productive of delightful friendships. They are destroyers of "ruts," the curse of the average specialist. While travel is probably the best rut-destroyer, the small society is very helpful in this respect.

The social side of these small groups should receive due consideration. Formal meetings in a large hall are usually inferior to meetings in the other fellow's office, where you can see how he does things and learn what he has to offer. It is a relief to get away from the lecture type of meeting of the large groups and gather in smaller numbers where questions are more numerous than didactic statements.

These meetings should not be too frequent. They should always be a source of anticipation, something to look forward to, not considered a burden. They should never interfere with the work and function of the county medical society which, as we have said, is the backbone of the parent society, the American Medical Association.

Just as there is a Section of Radiology in the American Medical Association, so there should be a radiologic section in our state societies and this may be achieved by the organization of the small groups.

These words will have fulfilled the purpose of the speaker if they encourage the formation of small informal societies where the enthusiasm aroused by national society meetings may be kept alive.

P. M. HICKEY, M.D.

THE EDUCATIONAL NUMBER

There will be found in this issue a group of papers relating to the teaching of radiology, which we believe will be most acceptable to the student interested in this phase of medicine. They deal both with the theory and the technic of radiology. The writers are cognizant of the needs of (1) men in general practice in rural communities, where, remote from the opportunities associated with medical centers, the problems of diagnostic roentgenography must be met daily; (2) of clinicians and surgeons who desire to acquaint themselves with roentgen shadows of the normal and of the infinite variety of pathologic deviations therefrom, and (3) of men whose object is to perfect themselves in all branches of diagnostic work and therapy to the end that they may become specialists in the making and interpretation of X-ray films and in the employment of radium.

In these papers are embodied suggestions of value alike to professor and student—what and how to present the instruction and what the learner has a right to expect and how he may co-operate with the greatest advantage to himself.

Last year the Educational Number presented the courses of study open to students of radiology, arranged by teaching centers, with all available information and the addresses of such schools. As the years mark the opening up of new opportunities, RADIOLOGY proposes to present them to its readers in an annual issue devoted to educational advances in this field of medical knowledge.

SECTION ON RADIOLOGY

American Medical Association

The preliminary program of the Section on Radiology will be published in the *Journal of the American Medical Association* for April 16, 1927, to which our readers are referred. An intensely interesting program and one concerned with matters of vital interest to radiologists is in preparation, one calculated to well repay all members of the Society who are so wise and fortunate as to attend the Washington session.

The officers of the Section are: Albert Soiland, M.D., Los Angeles, *Chairman;* E. C. Samuel, M.D., New Orleans, *Vice-chairman;* F. M. Hodges, M.D., Richmond, Virginia, *Secretary.* The Executive Committee is comprised of P. M. Hickey, M.D., Ann Arbor, Michigan; A. C. Christie, M.D., Washington, D. C., and Albert Soiland, M.D., Los Angeles.

EUROPEAN PUBLICATIONS

The Annual Tables of Constants and Numerical Data, published under the patronage of the International Research Council and of the International Union of Pure and Applied Chemistry, by the International Committee instituted by the Seventh Congress of Applied Chemistry (London, June, 1909), is issued under the general secretaryship of M. Charles Marie, 9 Rue de Bagneux, Paris VI, France.

Numerical Data for Radio-activity: Atomic Properties, Electrons, Ionization.

By Mlle. I. Curie and J. Saphores. Extracted from Vol. V (data for years 1917-1922, inclusive). This publication forms a volume of 120 pages, containing all the documents relating to radio-activity for the years mentioned.

In order to make these Annual Tables known, M. Marie sends out, free of charge, one of the following pamphlets, extracted from the above mentioned volumes: (A) Spectroscopy; (B) Electricity, Magnetism, Electrochemistry; (C) Radio-activity; (D) Crystallography, Mineralogy; (E) Biology; (F) Engineering, Metallurgy; (G) Colloids.

Members of the Radiological Society of North America are offered reduced prices on the complete volumes: 31 francs, 50, instead of 42 francs, for the bound copy; 21 francs, instead of 28 francs, for the paper-covered copy.

AMERICAN RADIUM SOCIETY

The American Radium Society will hold its twelfth Annual Meeting in Washington, at the Mayflower Hotel, Monday and Tuesday, May 16 and 17, 1927. The Program and Local Arrangements Committees have arranged a most interesting scientific program, as follows:

May 16, 1927, morning session

1. Dr. J. A. Corscaden. "Arthritis and the Radiotherapeutic Menopause."
2. Dr. Leda J. Stacy. "Complications Following the Use of Radium in Gynecology."
   Discussion: Dr. C. E. Norsworthy, Dr. W. S. Stone, Dr. F. J. Taussig.
3. Dr. William L. Brown. "Radium in the Treatment of Leukemia."
   Discussion: Dr. H. H. Bowing, Dr. Robert E. Fricke, Dr. George R. Minot.
4. Dr. M. J. Sittenfield. "Critique of the Biological Effects of Radium in Cancer."
   Discussion:
   Dr. H. J. Ullmann,
   Dr. Edwin C. Ernst,
   Dr. Robert B. Greenough.

May 16, 1927, afternoon session

5. Dr. Ira I. Kaplan. "Mouth and Face Conditions Treated by Radium Emanation at Bellevue Hospital, New York City."
   Discussion:
   Dr. Robert P. Wadhams,
   Dr. J. M. Johnson.
6. Dr. Isaac Levin. "Radium *versus* Roentgen Therapy in Carcinoma of the Cervix."
7. Dr. L. A. Pomeroy. "Five-year Results of Radium Treatment in Carcinoma of the Cervix Uteri."
   Discussion:
   Dr. William P. Healy,
   Dr. Clark D. Brooks,
   Dr. Grant E. Ward.
8. Dr. G. Failla. "Designs of a Well-protected Radium Pack."
   Discussion: Dr. Otto Glasser.
9. Dr. G. Allen Robinson. "Radium Treatment in Tuberculous Adenitis."
   Discussion:
   Dr. H. H. Bowing,
   Dr. George E. Pfahler.

May 16, 1927, evening

6:30 p. m., Annual Dinner. Speaker for the Banquet:
Dr. Franklin L. Hunt, Bureau of Standards, Washington, D. C.
Title: "Radiation Standardization Problems."

May 17, 1927, morning session

10. Dr. Sanford Withers and Dr. John R. Ranson. "The Treatment of Extensive Hemangiomas in Infants."
11. Dr. A. Strauss. "Radium Treatment of Cavernous Hemangioma and of Epulis."
12. Dr. William H. Schmidt. "Treatment of Cavernous Nevus Covered with Healthy Skin by Radium Needles."

    Discussion:
    Dr. Arthur C. Heublein,
    Dr. William Neill, Jr.,
    Dr. E. C. Samuel.
13. Dr. William L. Clark. "Combined Methods in the Treatment of Rectal Carcinoma."

    Discussion:
    Dr. Harvey B. Stone,
    Dr. Curtis F. Burnam.

May 17, 1927, afternoon session

14. Dr. H. K. Pancoast. "Radiation Treatment of Brain Tumors."

    Discussion:
    Dr. Douglas Quick,
    Dr. C. F. Burnam.
15. Dr. M. C. Sosman. "Response of Various Types of Gliomas to X-ray Therapy."
16. Dr. H. H. Bowing. "Malignant Tumors of the Thyroid Treated by Surgery, Radium and Roentgen-ray."
17. Dr. R. E. Loucks. "Clinical Evidences of Thyrotoxic Control after Radium Therapy."

    Discussion:
    Dr. T. D. Quigley,
    Dr. James T. Case,
    Dr. Douglas Quick.

All members of the Radiological Society and the Radiological Section of the American Medical Association are cordially invited to attend both the banquet and scientific sessions.

A COMMUNICATION

Baltimore, February 3, 1927.

Tissue Diagnosis in the Operating Room

And Immediate Cover-slip Examinations of all Fluids and Pus

Dear Sir:

I will consider it a courtesy if you will publish this letter in Radiology, as I am anxious to come in correspondence with pathologists and surgeons interested in the immediate examination, by frozen section, of tissue in the operating room and the immediate cover-slip studies of smears from all fluids and pus.

Microscopic examination of stained frozen sections has been possible for more than a quarter of a century. The staining of unfixed frozen sections with polychrome methylene blue and other stains is a well-established procedure. In many operating rooms in university and other large and small surgical clinics, provisions for these immediate diagnostic studies have not only been available, but have been in practical use for years, while, unfortunately, on the other side, this diagnostic part of the operating room is conspicuous by its absence in many clinics.

Before 1915 it was rarely necessary for a surgeon well trained in gross pathology to need a frozen section to help him in diagnosis at the operating table. Since 1915, and especially since 1922, the public has become so enlightened that malignant disease, formerly easily recognized either clinically or in the gross, now appears in our operating rooms devoid of its easily recognized clinical and gross appearance and can be

properly discovered only by an immediate frozen section. The majority of operating rooms are not equipped or prepared for this new diagnostic test.

The first essential part for this diagnosis is the technician—one to cut and stain the frozen section, or to make and stain the smear. The second is a pathologist trained to interpret it. It is possible for the surgeon to be all three in himself, and some young surgeons are so equipped. In others it is a dual combination—surgeon and pathologist in one, and the technician. More frequently it is three—operator, technician, and pathologist. It makes little difference whether it is one, two, or three individuals, providing each has the equipment and training for this most difficult diagnostic test.

In the address as chairman of the Surgical Section of the Southern Medical Association, I discussed biopsy, and this paper has been published in the *Southern Medical Journal* for January, 1927 (Vol. XX, page 18). A reprint of this paper will be sent to anyone on request. The chief object of this letter is to come in contact with surgeons and pathologists who are sufficiently interested in this problem to discuss it either by correspondence, or by attending a meeting in the surgical pathological laboratory of the Johns Hopkins Hospital, either the Monday before or the Friday after the meeting of the American Medical Association in Washington.

Schools for technicians may have to be established in different sections of the country, and the surgical pathological laboratories of the medical schools and the larger surgical clinics should offer courses in this tissue diagnosis, so that surgeons may learn to become their own pathologists, or pathologists learn the particular needs of the surgeon in tissue diagnosis in the operating room.

It is quite true that when the majority of the public are fully enlightened, the surgeon will see lesions of the skin and oral cavity and the majority of subcutaneous tumors when they are so small that their complete excision is not only indicated, but possible without any mutilation. The chief danger here will be a surgical mistake—the incomplete removal of an apparently innocent tumor. There is no necessity here for biopsy. If a proper local excision is done, no matter what the microscope reveals, that local operation should be sufficient. But when lesions of the skin, oral cavity, and soft parts are extensive and their complete radical removal mutilating, then there must be a biopsy to establish the exact pathology.

In tumors of the breast and disease of bone, for years, the diagnosis could be made clinically, or from the gross appearances at exploration. But now, in an increasing number of cases, the breast tumor must be explored, and the gross pathology of this earlier stage is not sufficiently differentiated to allow a positive diagnosis. Immediate frozen sections are essential to indicate when the complete operation should be done. The same is true of the earlier stages of lesions of bone. The X-rays no longer make a positive differentiation between many of the benign and malignant diseases, for example, sclerosing osteomyelitis and sclerosing osteosarcoma.

We must not only specialize in tissue diagnosis, but we must organize this department so it will function properly in as many operating rooms as possible in this country.

Then there is a final and most difficult question to consider. I doubt if it can be settled. What shall be done in those operating rooms in which there is no technician to make the sections and no one trained to interpret the microscopic picture? How can a piece be excised or a tumor removed, for example, from the breast, and this tissue sent to some laboratory for diagnosis without incurring the risk of the delay to the

patient? I have discussed this point in my paper on biopsy.

JOSEPH COLT BLOODGOOD, M.D.
Surgical Pathological Laboratory,
Johns Hopkins Hospital.

DR. LEWIS GREGORY COLE'S FILMS

American Medical Films, Incorporated, presents a group of fact films on various medical and surgical subjects.

All films are made on standard size non-inflammable stock and can be used in any standard or portable projector.

A reduction in price has been made on the Motor Phenomena and Tuberculosis films.

1. Gastric Motor Phenomena (2 reels; requires 36 minutes to run).
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Time of transportation is not charged. A reduced rate is charged for each additional day.

To secure definite dating, reservations should be made as far in advance as possible, as there are a limited number of prints available. Correspondence relative to these films should be addressed to Dr. Lewis Gregory Cole, 36 East 61st Street, New York City, or to James Picker, Inc., 686 Lexington Avenue, New York City.

BOOK REVIEWS

LA RADIOGRAFIA EN GINECOLOGIA, OBSTETRICIA Y UROLOGIA (Radiology of Gynecology, Obstetrics and Urology). By DR. CARLOS HEUSER, Tucuman 974, Buenos Aires, Associate Physician to the Hospital Alvear; Ex-Chief-of-Service of the Hospital N. de A.; Member of the Societies of Radiology of the Argentine Republic, Germany, United States, France, England, and Italy. Pages 202, with illustrations. Buenos Aires: Talleres Graficos "Mario," 1926.

This is a beautifully printed book with excellent half-tone illustrations, recording the author's experience in radiological examination in gynecology, obstetrics, and urology, especially aided by the introduction of pneumoperitoneum and opaque substances, such as lipiodol, and the Potter-Bucky diaphragm. The author, in 1922, encouraged by the good results of his bronchial injections of lipiodol according to the method of Sicard and Forestier, practised a similar method to obtain radiograms of the uterine cavity and the tubes. He presented reports of this work at the Third Pan-American Scientific Congress at Lima in 1924, the German Radiological Congress, and the Society of Radiology of Paris in 1925, and at the International Congress of Radiology in July of that same year. Dr. Heuser had previously done work with collargol in the bladder in 1912, and at that time had tried to obtain radiograms of the uterine cavity. He found that the various opaque substances which he and others had tried prior to the introduction of lipiodol had caused peritoneal reactions which were unpleasant; but with lipiodol, he declares, these unpleasant sequelæ no longer are en-

countered, and he is now enabled to study the permeability of the tubes as well as their deformities, the uterine cavity, internal tumors, and pregnancy as early as the second week.

The work includes a discussion of the various methods of radiographic examination in these three specialties: (1) visualization of uterine cavity as well as the tubes; (2) recognition of the different intrinsic pathological conditions of the uterine mucosa (polypi, intra-uterine fibroids, etc.); (3) differential diagnosis between fibroid tumors and pregnancy; (4) sterility from various causes; (5) development of the fetus during the period of pregnancy, whether intra- or extra-uterine; (6) diagnosis of malformation of the fetus; (7) diagnosis of death of fetus; (8) radiographic diagnosis of the various affections of the urinary tract; (9) a radiographic demonstration of the mucosal wall of the bladder by the method of impregnation with lipiodol, to recognize polypi, fibromas, ulcers, etc.; (10) the diagnosis of bone syphilis by a special sign of Dr. Heuser.

A discussion of bone syphilis occurs in the chapter on radiography of the urinary bladder, in differentiating between syphilitic and other disease of the bladder. In syphilis of the bladder, there are found bony metastases which are not seen in cancer of the bladder. These syphilitic metastases are small rugosities of one or more millimeters in height, seen in various portions of the innominate bone. In these bones there are rugosities on both sides which involve the bone symmetrically as well as the coxo-femoral articulation, generally occupying the lower part of the joint in the border of the joint cavity. These should call one's attention to the probability of syphilis rather than a tumor of some other nature when one is studying the bladder.

This is a work of over 200 pages, about half of which are given over to full-page illustrations in excellent half-tones, with discussions in Spanish, facing each illustration.

JAMES T. CASE, M.D.

TRATADO SOBRE RADIOTERAPIA SUPERFICIAL Y PROFUNDA (Treatise on Superficial and Deep Radiotherapy). By DR. CARLOS HEUSER, Tucuman 974, Buenos Aires, Argentina, S. A., corresponding member of the American Roentgen Ray Society; member of the Roentgen Society of London; member of the British Association for the Advancement of Radiology and Physiotherapy; recipient of the Gold Medal in the Circulo Medico Argentino (for thesis, 1902); Ex-Chief-of-Service of Electrotherapy of the Hospital N. de A. Cloth. Pages 407, with illustrations. Buenos Aires: "La Semana Medica," Imprenta de E. Spinelli, 1923.

This is a neatly printed, well-bound volume, of over 400 pages, crystallizing the author's experience in deep therapy. Really it is the second volume of a comprehensive work by the author on roentgen diagnosis and treatment, the first volume being devoted to roentgen diagnosis. This second volume on therapy contains chapters on apparatus, dosimetry, a consideration of the biological reactions of the organism to X-radiation, and then something over twenty chapters devoted to the technic and results of superficial and deep therapy. The author evidently has an extensive acquaintance with the literature on the subject and has contributed considerable to the subject from his own original work.

He illustrates a very interesting treatment chair of his own device which facilitates perineal applications of deep and superficial therapy.

An appendix to the work contains a number of illustrations depicting the results obtained from radiotherapy in the author's

personal practice. Dr. Heuser is to be congratulated on his energy, manifested by producing this work in addition to carrying on his busy practice.

JAMES T. CASE, M.D.

NUMERICAL DATA ON RADIO-ACTIVITY. Edited by MISS I. CURIE and J. SAPHORES. Published by Gauther-Villars et Cie, Paris; The Cambridge University Press, Cambridge, England, and the University of Chicago Press, Chicago, 1926. Pages 38. Price uncertain.

The material contained in this volume is extracted from Volume V of the Annual Tables of Constants and Numerical Data, Chemical, Physical, and Technological, published under the patronage of the International Research Council, the International Union of Pure and Applied Chemistry, and the International Committee named by the Seventh Congress of Applied Chemistry (London, June, 1909). The American members of the International Committee include Professor E. C. Franklin, Leland Stanford University; Professor H. G. Gale, University of Chicago; Professor A. P. Mathews, University of Cincinnati, and E. W. Washburn, of Washington.

The volume contains important physical data on electrons, atoms, and molecules; on the values of Panck's constant, as found by Blake and Duane; Duane, Palmer and Yeh; Millikan and Holweck; data on the experimental verification of the Lorentz-Einstein formula; on the photo-electric emission of electrons under the action of roentgen rays (de Broglie, Whiddington, Shearer); on secondary electronic emission (Barber); on ions and electrons in gases (Wellish, Wahlin, McLennan and Evans, Erikson); on mobility spectra; on critical potentials; on the spectra of characteristic rays (roentgen rays) as determined by various workers including Siegbahm, Hjalmar, Dogelsek, Dauvillier, and others; on absorption, including coefficients of atomic and molecular absorption; coefficients of mass absorption in function of the wave lengths; on absorption of soft X-rays, and fundamental data on various phases of radio-activity. This volume is of great value to physicists and others interested in the physics of radiation. It consists entirely of tables of values determined by various experimenters throughout the world and is intended to provide other experimenters with these values in condensed form for reference.

ARTHUR U. DESJARDINS, M.D.

ABSTRACTS OF CURRENT LITERATURE

INDEX TO ABSTRACTS IN THIS ISSUE

Irradiation effects upon the generative organs and offspring.—Years ago, observations based on the reaction of rats' testicles caused the formulation of the so-called law of Bergonié and Tribondeau which states that "immature cells and actively dividing cells are more sensitive to roentgen rays than are the adult type of cells." Since then, studies have been made on the ovary and on malignant growths and the action of radium is found to be similar to the action of the roentgen ray.

Destructive reaction follows irradiation of the gonads, causing atrophy of the ovary, destruction of the graafian follicles (sometimes with cyst formation), degeneration of germinal epithelium, while the corpus luteum is less readily affected. The seminiferous tubules show degeneration, with changes in the cells of the various layers and absence of spermatozoa. The reaction, of course, depends on the severity of the dose and the time elapsing between the dosage and the examination.

The author is of the opinion that irradiation is always destructive, although the biological response is complicated. Since dosage is given to produce results ranging from atrophy of the entire ovary to temporary inhibition of function, it is possible to partially injure the ovum which may later develop into an embryo.

Animal experimentation shows that profound alterations in the germ plasm occur and offspring accordingly suffer; there is also evidence of injury to mammalian offspring. Female rabbits treated with roentgen rays subsequently produced defective offspring in the first generation.

The author's experiments showed that when both male and female parents were irradiated with light doses, all offspring were apparently normal, but their descendants were blind and had defects of the limbs. These defects did not occur in control animals. However, later experiments do not show the same results. These results do not mean that the first experiments were incorrect but that the chances are against modifying germ cells at will.

The effect of irradiation on the embryo with a dosage light enough to have no effect on the mother, may be to produce abortion or cause an arrest of development including blindness, defects of the central nervous system, or sterility—sometimes all.

There is comparatively little, if any, change noticeable at birth when irradiation has occurred late in pregnancy, but the future may show disturbed growth, eye defects, or possible sterility. A follow-up of children born under such conditions though apparently normal at birth, should be made by competent anatomists and should extend over a considerable period of time, else the results may lead to erroneous conclusions.

There is no agreement at present as to what constitutes a sterilizing dose for humans and further work is necessary along these lines.

TRESSA R. MORAN, M.D.

The Present Status of Our Knowledge of the Effect of Irradiation upon the Generative Organs and the Offspring. Halsey J. Bagg. Am. Jour. Roentgenol. and Rad. Ther., December, 1926, p. 529.

Pulmonary conditions.—Long and careful observation of large groups of tuberculous patients, clinically and by serial plates, has proved the value of roentgen examination to the profession and emphasized the value of negative plates. During the past ten years, sanatorium workers have proved that (1) caseous tuberculosis with cavities may almost entirely disappear under treatment; (2) extensive inflammatory or exudative types of tuberculosis may entirely disappear; (3) the majority of localized exudative lesions clear up entirely.

The controversy existing a few years ago as to the earliest X-ray evidence of tuberculosis brought about a better understanding and it is now generally accepted that the earliest sign for definite diagnosis is the typical mottling first described by Cole.

Many of the so-called "typical" infiltration areas in the outer quadrant of one or both upper lobes clear within a few weeks or become typical conglomerate tubercles, sometimes with extension of the process. Cases with positive sputum usually remain un-

changed at the end of from six to eight weeks. A critical review of such cases has given no information as to the differentiation between tuberculous and non-tuberculous lesions at the first examination.

The prognosis of a known tuberculous lesion can be determined only after several series of plates have been taken, extending over a period of months. A definite diagnosis of tuberculosis should be made only after a second set of plates, 4 to 6 weeks after the first examination, in which the changes in shadows may be determined. The patient should be treated as a suspect in the meantime.

The author warns against sterilization until a period of observation proves the progress of the disease, although a therapeutic abortion may be necessary.

TRESSA R. MORAN, M.D.

Resolution in Pneumonic Consolidations. R. G. Allison. Am. Jour. Roentgenol. and Rad. Ther., December, 1926, p. 549.

Lipiodol in chest diseases.—Lipiodol, in the lung, is partially expectorated but has been known to remain for as long as 65 days. It causes little inconvenience in the bronchi. As much as 50 c.c. has been injected in one patient without any bad results, 77 injections having been made. In one case of advanced bilateral tuberculosis with small heart, acute cardiac dilatation resulted in death.

This author uses direct bronchoscopy and examines the larynx, trachea, and bronchi. Pus and secretions are aspirated and 10 to 40 c.c. of warm lipiodol is injected with a long Lukens bronchoscopic syringe. It is thus possible to inject any lobe of the lung. Roentgenograms are taken with the patient in the recumbent position as well as in the lateral.

Bronchiectasis, while not easy to diagnose clinically, or by X-rays, gives a characteristic picture with lipiodol.

In lung abscesses, lipiodol enters the abscess only if it communicates with a bronchus or bronchiole and is not filled with pus.

Cavities in tuberculosis which are empty and communicate with a bronchus, are easily injected, but the method is unnecessary. Some bad results have occurred, due to exacerbation of the disease.

Stenosis of the trachea and bronchi, as in newgrowths, are well shown.

In thoracoplasty, the post-operative effects are well demonstrated.

TRESSA R. MORAN, M.D.

Diseases of the Chest Demonstrated by Lipiodol. A. Howard Pirie. Am. Jour. Roentgenol. and Rad. Ther., December, 1926, p. 553.

Etiology of cancer.—Gye's work was first reported in 1925, since which time many laboratories have been working along similar lines. Gye makes use of an anaerobic culture of tumor tissue filtrate, elaborating the work of Rous, who, in 1911, found that spindle cell sarcoma of the Plymouth Rock fowl could be transmitted to other fowl of the same species by a cell-free filtrate of tumor extract. This presumes the presence of a filterable virus.

Gye claims that the infectivity of the Rous tumor persists for from two to four days but the anaerobic culture prolongs the activity for from six to nine days—especially if fresh rabbit serum is added to the culture.

According to Gye, two factors are responsible for the tumor production: (1) a non-specific filterable virus—ultra-microscopic—common to all tumors; (2) an accessory, unstable chemical agent peculiar to each tumor, called the "specific factor" as the decisive agent. While both agents are essential, it is the specific factor which determines the histological and biological character of the tumor. Gye has attempted to separate these two factors, but the results are not yet definite. While filtrates of the Rous tumor have produced tumors, the filtrates of other sarcomata have not been successful.

The author has attempted to verify or disprove some of Gye's work, particularly on the filterability of the mouse tumor. To this end he injected 183 mice subcutaneously with filtrates of tumor extract, prepared according to Gye's method. Eight developed tumors of the

same histological character as the original about 23 days after the injection. As controls, 53 mice were injected with the culture media, minus the tumor extract. In no instance did a tumor develop.

A second series of 105 mice were injected with the cell-free supernatant fluid from the tumor cultures, instead of the filtrate. Of these, 34 developed tumors in about 17 days after the injection. The histological characteristics were like the original sarcoma.

Other experiments with mouse carcinoma were carried out, using the original technic In 27 mice injected with the filtrate, no tumors resulted, while the supernatant fluid produced two tumors in 81 mice. The tumors appeared on the tenth and fourteenth days, respectively.

Discussion of the factors in the experiments includes such as the diluents, the filter candles, the tumors, sensitivity of animals, etc. The author confirmed Gye's statement that chloroform inactivates the filtrates.

More knowledge of both factors, if they can be proved, may give facts in the etiology of cancer. "These new discoveries open up an entirely new avenue of approach and the cancer student has something tangible to work on."

TRESSA R. MORAN, M.D.

New Research in the Etiology of Cancer, with Reference to the Work of Gye. M. J. Sittenfield. Am. Jour. Roentgenol and Rad. Ther., December, 1926, p. 525.

Liver measurements.—After a study of 502 subjects, the author concludes that an accurate record of the size and position of the liver should be made as routine in every abdominal examination, by means of the Potter-Bucky diaphragm. An antero-posterior exposure is made on a 14 × 17 film in a double screen cassette, so placed as to include about one inch of the iliac crests. The tube is centered over the ensiform cartilage at a target-film distance of 25 inches. Only the right lobe is clearly shown, but this is the most important. The "length" is measured from the highest point of the upper border to the lowest point of the tip. The "thickness" is measured from the upper border to the lower border in an oblique direction.

Of the 502 subjects, 324 were classed as normal, since there were no symptoms referable to liver involvement. They were analyzed with regard to sex, age, height, weight, and abdominal thickness. The average length of the shadow of the right lobe was 21.3 cm. (18 to 22 cm.) and the average thickness was 12.8 cm. (10 to 14 cm.).

Age, sex, height, weight, and body thickness have very little effect on the size of the normal liver. In patients with abdominal symptoms, many conditions are associated with enlarged liver. Enlargement was found in intestinal stasis, gall-bladder disease, cardiac disease, and metastatic carcinoma. Tables showing details of the study are given, together with reproduction of films.

TRESSA R. MORAN, M.D.

The Measurement of the Liver by Means of Roentgen Rays: Based upon a Study of 502 Subjects. G. E. Pfahler. Am. Jour. Roentgenol. and Rad. Ther., December, 1926, p. 558.

Rectal cancer.—This is an especially interesting article because of the author's careful analysis of the prognosis in untreated cases, the success he reports in his operations, and the inadequacy of radiation treatment as he has seen it. There are three main factors of the greatest importance in estimating prognosis: age of the patient, the stage of the disease when first seen, and the position of the growth. In young people the tendency is for the disease to grow with extreme rapidity and to spread, while in the very old, the disease is apt to be extremely chronic and to grow slowly. He has seen a patient as young as 8 years with cancer of the rectum, but, fortunately, he found it rare under the age of 40.

The prognosis under the age of 30 is extremely bad. He has no record of any patient treated for cancer of the rectum under 30 who has not died from prompt recurrence, no mat-

ter how drastic the operation or treatment has been. He does not believe it worth while to operate at all on a patient under 30. He has seen very old patients—of 80 or more—who had had carcinoma for many years, the growth of which was so extremely slow that it was doubtful whether it was worth operating upon, even if possible. He has had one patient 85 years of age, who has had an epithelioma of the anus for 25 years and to all intents and purposes the disease is behaving like a wart. There is no doubt of the diagnosis, a microscopic examination having been made on three different occasions.

He emphasizes the importance of seeing the disease early. The prognosis after the operation is markedly influenced by the age of the disease, as it always is in cancer. The prognosis in an epithelioma of the anus is good provided the diagnosis is made early. Fortunately this is usually the case because the position of the tumor quickly draws attention to itself and it can be seen easily. Growths in the rectum also have a good prognosis, provided they are detected early and suitably operated upon. Those at the rectosigmoidal junction have not such a good prognosis as those in the rectum, as they can be removed only by a more serious operation, and it is more difficult to remove the secondary glands in the immediate vicinity. They are also less liable to be detected until a late stage of the disease. He refers to the figures of Lazarus-Barlow and Leeming, published in the *British Medical Journal,* August 16, 1924, as the only satisfactory figures bearing on the prognosis of untreated cases. They give a mean duration of 21 months. There are, of course, extremes, and this is the average. Some may die within a few months while others may live for many years. The author's mortality in operations has been only 3 per cent and he lays this percentage to careful team-work between himself and his assistants.

He believes that so many recurrences appear after 3 years that reporting recurrence rates on a 3-year basis gives a false impression. A 5-year period is much more satisfactory, although still open to the objection that recurrence may occur after 5 years. But the great difficulty of keeping in touch with a large number of patients and the fact that a considerable number will die of other causes, render it impossible to take anything more than a 5-year period. He reports 95 cases operated on 5 years ago or more.

Cures on a 5-year basis	45
Recurrences	37
Died from other causes	6
Untraced	7
Total	95

When the untraced patients and those who died from other causes are subtracted, this gives a percentage of 5-year cures of 54.8. The author made an attempt to trace the after-history of 39 of his patients who survived the 5-year period. He found one of 21 years, two of 14, two of 11, three of 10 and 31 cases living over a period of from 6 to 9 years.

Lockhart-Mummery discusses the disability produced by operation but considers it a relatively unimportant factor in dealing with this serious and fatal disease, but it is of considerable importance when comparing one method of treatment with another. He considers the disability from a perineal operation not a serious one, as patients are able to live comfortable and useful lives and after the first few months many show little inconvenience from colostomy causes. Estimating the disability in reference to the wage-earning capacity of hospital patients, he finds that this is not diminished except in the case of very heavy labor involving strenuous exertion. A large majority of his patients were found to have been in the same employment as formerly. He summarizes that when an operation is performed for cancer of the rectum under the most favorable conditions and when the growth has been diagnosed at an early stage, the prognosis as regards cure is good. The mortality is only 3 per cent and the percentage of cures on a 5-year basis in early growths is 73 per cent, while the average of cases as they present themselves is over 50 per cent. But he emphasizes that these results can be obtained only by a surgeon having considerable experience in operations on the rectum

and when the case is handled to a large extent by team-work.

He states that he has not seen any cures from X-radiation and considers it decidedly dangerous, as he has seen one death after such treatment. He refers to so-called deep roentgen ray only. He has seen good results from roentgen rays in treating epithelioma and he believes that one case has been cured by this means.

He knows of no cure of a case of cancer of the rectum from the use of radium. He is, however, using it in certain cases but only by the implantation of needles. He has not yet had sufficient experience with this method of using radium to report any results. He says, however, that, so far as they go, they are better than the old method of capsule application.

The author believes that the use of colloidal copper undoubtedly does good, and his experience has now run over 200 cases. He has seen two cases which were apparently cured by this means. He says that he uses the word "apparently" because in both an undoubted carcinoma of the rectum entirely disappeared after some eight or nine months of continuous treatment with colloidal copper, but he cannot be sure, when the proportion of cures is so small, that the cure was due to the copper and not to some other circumstance. Apart from these two cases he is certain that the treatment does much good. He believes that it delays the growth of the tumor and reduces the secondary ulceration: it seems to act by tending to fibrose the growth. In practice, it tends to prolong the patient's life and to increase his comfort and well-being. There is, so far as he knows, no danger from the treatment.

The treatment with colloidal lead is on a different footing, as a considerably greater proportion of cures is claimed for this method of treatment. This treatment is at present still in the experimental stage, but the results are very encouraging. Unfortunately, there is considerable danger attending the use of colloidal lead, both from the rapid reaction of the tumor itself and from the acute plumbism from the direct effects of the lead in the circulation.

This paper is well worth reading by any one who is interested in cancer.

H. J. Ullmann, M.D.

Prognosis in Rectal Cancer. J. P. Lockhart-Mummery. Lancet, Dec. 25, 1926, CCXI, 5391, p. 1307.

The erythema dose for characteristic radiation of copper.—The authors measured the erythema dose in roentgen units for the radiation of lambda effective equal to 1.47, which comes very close to the most intensive K line of copper (lambda equals 1.54 Ångströms). The half value layer in aluminum was 0.06 millimeter and 0.8 millimeter in water (50 K.V. effective, 9 ma., 76.6 cm. distance, 2.09 *R* per second). Another radiation of an effective wave length of 0.42 Ångström, 1.84 millimeters half value layer in aluminum, 17 millimeters in water (100 K.V. peak, 0 – 3 Al.) produces an erythema when applying the same amount of energy as the first described quality of roentgen rays, namely, 380 roentgen units measured on the skin.

E. A. Pohle, M.D.

The Erythema Dose in Roentgen Units for Characteristic Radiation of Copper. G. H. Kloevekorn and O. Gaertner. Strahlentherapie, 1926, XXIV, 365.

The biological effect of radiation.—The author has undertaken a series of experiments in an attempt to furnish the indirect biological proof for the point-heat theory of Dessauer in connection with the Necrohormone theory of Caspari. The direct change of albumins under the influence of roentgen rays (40 K.V. and 215 K.V.), manifesting itself in different molecular motion (Brown), was studied in the ultra-microscope. Rutil sol (crystallized titan dioxyde), globolin sol, with and without buffer, constituted the test solutions, while cells taken from the mucous glands of snails (*Linnaeus stagnalis*) and

ameba (*A. Rostock*) represented the living material in the experiments. It appears that rather complex results were recorded following the absorption of roentgen energy and they are difficult to interpret. Microscopically, an agglutination of small particles in the before-mentioned sols took place, corresponding to a visible clouding of the formerly clear fluid. One or two maxima could be noted in this microscopic reaction; both changes were independent of the amount of absorbed energy. Control experiments consisting of heating the sols directly showed similar changes to those seen after irradiation. The author states that his work is still incomplete and he emphasizes the necessity of further experiments along these lines. He feels that all his observations so far agree very well with the two above-mentioned theories and nothing has been seen in his investigations that is at variance with them.

E. A. POHLE, M.D.

Experiments Concerning the Principal Mechanism of the Biological Effect of Radiation. Y. Nakashima. Strahlentherapie, 1926, XXIV, p. 1.

Iodized oil in bronchiectasis.—The author emphasizes the value of the endobronchial injection of iodized oil in the diagnosis of bronchiectasis, and in the treatment of certain cases of this disease. The method of injection adopted in the chest department of the Battle Creek Sanatorium is the supraglottic one. The conclusions of this paper are drawn from 800 injections in 150 patients.

The diagnostic value of endobronchial injections of iodized oil lies in its fluidity, its opacity to X-rays, its tolerance by the bronchial mucous membrane, and its comparative ease of administration. The therapeutic value lies in the fact that it can be applied directly to the bronchial mucous membrane, where it slowly gives up its iodine.

The supraglottic is the method of choice because it is simple, brief, satisfactory, and requires only a small amount of local anesthetic.

The technic is simple. The patient is seated. The soft palate and posterior tongue are anesthetized by swabbing with a 5 per cent butyn or a 10 per cent cocaine solution. With a small syringe 1 to 3 c.c. of a 2 per cent butyn solution is dropped into the larynx. In five minutes the operator holds the tip of a 20 c.c. laryngeal syringe over the glottic opening and slowly drops 15 c.c. of the warm oil into the trachea. The field of operation is visualized by a head light and laryngeal mirror.

The position of the patient, sitting, suffices for filling the bronchial tree below the hilus, where 90 per cent of bronchiectases are situated. For the filling of the bronchi on the right side the patient should be inclined to the right. For injection of the middle and ascending bronchi the patient should be placed on a tilting table with the desired side downward. By tilting the head downward for a minute immediately after the filling the ascending bronchi are filled.

Contra-indications to the use of iodized oil are acute pulmonary disease, cardiac decompensation, and cachexia.

For therapeutic use 5 to 20 c.c. are injected at intervals of from five to fourteen days. Fourteen cases of bronchiectasis are reported as treated by this method, with marked improvement.

L. J. CARTER, M.D.

Iodized Oil with Reference to Bronchiectasis. Bruce Whyte. Can. Med. Assn. Jour., December, 1926, p. 1443.

Roentgen therapy of mastitis.—The author recommends the treatment of mastitis with roentgen rays, using 3.0 aluminum or 0.5 copper, 30 to 40 centimeters F.S.D., 20 per cent E.D. = 150 *R*. The field must be large enough to cover slightly more than the area of inflammation.

E. A. POHLE, M.D.

The Treatment of Mastitis with Roentgen Rays. E. Zweifel. Strahlentherapie, 1926, XXIV, 318.

X-ray treatment of acute lymphatic leukemia.—This is the report of a case in which, contrary to text book instructions, X-ray treatment was given as a last resort, with results appreciated by both the clinician and the family of the patient.

The patient was in a very grave condition, and X-ray treatment over the spleen and long bones was given as a temporary expedient. There was a prompt response, the leukocyte count falling rapidly from 93,200 to 1,700. When the count began to rise again treatment produced the same result, with a corresponding improvement in the general condition of the patient. By means of this treatment the patient's life was prolonged, and he was kept quite comfortable.

L. J. CARTER, M.D.

Acute Lymphatic Leukemia: A Case Report. A. Stanley Kirkland. Can. Med. Assn. Jour., December, 1926, p. 1500.

Irradiation of the whole human body.—Far advanced cases of malignancy were subjected to total body irradiation with apparently no ill effects. The maximum dose corresponded to 60 electrostatic units or 1.4 million $e \times 1$ c.c. (for details of the calculation, see *Strahlentherapie*, 1924, XVII, 331). In 3 out of 18 patients a definite improvement could be observed. The method is recommended as a last attempt in desperate cases.

E. A. POHLE, M.D.

On the Total Irradiation of the Human Body with Roentgen Rays. A. von Liebenstein. Strahlentherapie, 1926, XXIV, 324.

Milk irradiated with ultra-violet light.—This paper is a report on the effect of milk irradiated with ultra-violet light on anemic children. The authors refer to the work of Hess, Cowell and others to show that the exposure of certain foods to ultra-violet light confers antirachitic properties upon them which they did not originally possess. One of the authors, Pattison, has found similar good effect of the irradiated milk on the calcification of bones and general condition of patients with osseous tuberculosis.

They refer to conflicting statements regarding the effect of this radiation on the blood. They state that, although the early workers showed that the number of red cells was increased, this has not been confirmed and it is now generally considered to be due to a higher concentration of the blood. In their work, observations were made on children who had been in the hospital with active bone tuberculosis for an average period of four months, without marked improvement in either general condition or local lesion. During this period the patients had been given, in addition to the ordinary hospital diet, cod liver oil and 1¼ pint of milk daily, and Dawkins and Pattison state that the diet in general was good, especially from the point of vitamin content. They selected five patients with the smallest red cell counts for the experiment. They irradiated ½ pint of the 1¼ pint of milk fed in these diets. This milk was exposed daily to a quartz mercury vapor lamp at a distance of 2 feet for half an hour. The milk was in shallow trays and frequently stirred. No change was made in the balance of the diet. After four weeks, they found that the red cells and hemoglobin were increased in all these patients. At the end of another four weeks, a further increase of the red cells was found but the hemoglobin varied. Then they ceased radiating the milk for four weeks and a fall in the reds occurred in every case, with a reduction of hemoglobin in four out of five of the patients. They then repeated their radiation and at the end of three weeks the red cells had in every case increased; the hemoglobin, however, was only slightly altered. In one case its percentage was increased, in two cases it was unaltered, and in the remaining two decreased.

The authors state that the improvement in the happiness and general health of these children after eight weeks of feeding on radiated milk was extremely marked, and the local lesion had also improved. As a whole, in these five children, while there was a definite increase in the red cells at the end of the

experiment, there was a uniform slight decrease in the hemoglobin.

They then investigated the blood of six other children between the ages of two and fourteen years who had been on radiated milk daily for an average of ten months. They found that the average red count was 5,030,000 and the average hemoglobin 78 per cent; the average red count of the experimental cases at the end of the period of observation was 5,300,000, hemoglobin 70 per cent. They suggest that the fall in the hemoglobin found in their experimental cases does not occur for long, and that the rise in the number of red cells is not continued above a certain point. They wisely draw no conclusion from this small series of cases and suggest that further work in this direction may be desirable because of the results found.

H. J. Ullmann, M.D.

Irradiated Milk: Its Effect on the Blood. Veronica Dawkins and C. Lee Pattison. Lancet, Dec. 25, 1926, CCXI, 5391, p. 1314.

Calculi of salivary glands.—The author concludes, from an experience of 27 cases, that calculi of the salivary glands and ducts are not very rare, and are of interest because of the difficulty in diagnosing them and the satisfactory results following timely removal. They are usually single, but may be multiple. They occur at all ages and in any of the glands, though the submaxillary is the one most frequently involved.

Harrison classifies these patients as follows: (1) Those complaining of pain and swelling in the gland or duct upon the ingestion of food; (2) those giving a history of sudden pain and swelling, with fever, without any previous history of recurrent swelling, and (3) those presenting a hard swelling fixing the tissue of the involved gland or duct with, frequently, cellulitis of the neck, and suppuration. X-rays give positive information in from 75 to 80 per cent of cases after repeated and careful examination. Treatment consists in removal of the calculi through an intra-oral incision if they are situated in the sublingual duct or gland, the anterior two-thirds of the submaxillary, or the buccal portion of the parotid ducts, but through an external incision if they are in the masseteric portion of the parotid duct, the parotid gland, or the posterior third of the submaxillary duct or the submaxillary gland. If stones are situated in either the sublingual or submaxillary gland, extirpation of the gland is indicated, and in order to prevent fistula formation gland removal is sometimes advisable when the calculi are located in the ducts, especially when there is accompanying inflammation. Incisions must be made with great care because of the possibility of injury to motor nerves. Stones should be removed regardless of whether they are producing symptoms or not, because their presence is always a potential source of danger.

Calculi of the Salivary Glands and Ducts. G. R. Harrison. Surg., Gynec. and Obst., October, 1926, p. 431. (Reprinted by permission from Brit. Med. Jour., Dec. 11, 1926, p. 92 of Epitome of Current Medical Literature.)

Testing device for the Fuerstenau intensimeter.—In order to control the constancy of the selenium cell, an electric bulb is used, burning under constant potential and current. This is said to enable the physician to check the intensimeter easily before each measurement.

E. A. Pohle, M.D.

Testing Device for the Fuerstenau Intensimeter. W. Roever. Strahlentherapie, 1926, XXIV, 368.

Stimulating roentgen therapy in gynecology.—There is no satisfactory explanation for the effect of small roentgen-ray doses on cells, organs, and organisms. Clinical experience shows, however, that in a number of gynecological conditions, therapy leads to encouraging results. Cases suitable for treatment with small doses (4 to 6 per cent E. D.) to the ovaries are dysfunctions of various types and degrees. In the author's clinic 50 per cent of the cases of amenorrhea returned to normal. Irradiation of other glands of in-

ternal secretion (hypophysis and thyroid) may also be of benefit in regulating menstrual disturbances. Results have been seen in attempting relief from climacteric symptoms. Very small doses (5 to 10 per cent E. D.) are advisable. An exposure to the spleen has also sometimes a correcting influence. The high blood pressure during the menopause may be lowered by treating the ovaries. Inflammatory diseases have been successfully handled by radiotherapy. Well known is the styptic effect of spleen exposure. Twenty-five to 30 per cent E. D. of hard rays through a large field is recommended.

E. A. POHLE, M.D.

Stimulating Radiotherapy in Gynecologic Diseases. L. Seitz. Strahlentherapie, 1926, XXIV, 227.

The Compton effect in radiotherapy.—Two well known scientists, a physicist and a physician, give in the papers abstracted below their viewpoints concerning the rôle of the Compton effect in radiotherapy.

Friedrich discusses the Compton effect (see this Journal, 1924, III, 479) from the physical standpoint, based on the original experiments of Compton, his own, and his co-workers, and on the more important reports in the recent literature. The essence of this effect lies in the perception that the wave length of scattered radiation is longer than that of the primary waves. Some of the discrepancy in the measurements in the surface and depth dose and of the distribution of roentgen energy in water may be explained by the Compton effect. The still pending question regarding the intensity in a body outside the entering beam of rays as defined by the diaphragm can be answered to the effect that the shorter the wave length, the less side and back scattering is to be expected. The importance of using ionization chambers fairly independent from the wave length should always be remembered. The next step in radiation research will be an investigation of the quantitative relation of the Compton effect to dosimetry.

Wintz sees as the principal importance of the Compton effect, its influence upon the biological action of hard rays due to the change in the wave length of scattered radiation and also upon the ionization instruments used at present in dosimetry. Ionization and skin reaction do not run parallel. The Compton effect offers an explanation for this observation inasmuch as the wave length difference is the same for all primary radiation and rays of short wave length must be affected relatively more. Recoil electrons cause, therefore, a higher percentage of the total ionization when hard primary rays are used. A new method of measuring the dose which is based on the expansion of an irradiated body proportional to the amount of the absorbed energy transformed into heat is suggested. The different biological effect of soft and hard rays may also be due to the Compton effect because rays of long wave length have to pass less transformation until a photochemical effect takes place than rays of short wave length. Furthermore, energy transformation always means energy loss. This would be relatively smaller for roentgen rays of long wave length.

E. A. POHLE, M.D.

The Compton Effect and its Significance in Radiotherapy. W. Friedrich. Strahlentherapie, 1926, XXIV, 193.

The Compton Effect in Deep Therapy. H. Wintz. Strahlentherapie, 1926, XXIV, 218.

Neoplasms of the bladder.—An improved method of treating neoplasms of the bladder by means of removable platinum radon seeds is described in this article. Using these, it is possible to obtain scientific accuracy of the dosage delivered. Radiation is directed not only to the growth itself, but to the tissue surrounding it, in order to catch the mitotic cell. The placement of the radio-active units is made so that the "zones of potential tissue change" from each source do not overlap. The "zone of potential tissue change," or the amount of tissue that one seed can take care of when implanted alone and also when two or three centers are used so that intervening cells are subjected to cross-firing, is described. The theoretical *expose* has been proved by clinical results.

Using the removable platinum radon seed, not only is one able to deliver accurate dosage,

but because of the platinum screenage all caustic rays are eliminated and necrosis and sloughing, with intense shock to the patient, obviated. The fact that the seeds are easily removed through the cystoscope after the required amount of radiation has been delivered makes this the method of choice, since no foreign body is left in tissue after treatment.

The technic of application is fully described and illustrated. A point of great importance in using the removable platinum radon seeds is that after the first seed has been implanted through the cystoscope, its thread protruding from the portal of entry of the seed in tissue serves as a landmark and guide for the placement of successive seeds, so that the accuracy of placement of seeds through the cystoscope is greatly increased. Also, should a seed be incorrectly implanted, it may be removed and re-implanted.

In view of the highly simplified technic as described, the treatment of vesical neoplasms by implantation of removable platinum radon seeds can be accomplished with as much scientific accuracy as any other urologic procedure.

Irradiation of Vesical Neoplasms by Removable Platinum Radon Seeds: Description of New Instruments Designed to Facilitate Their Employment. Joseph Muir. Jour. Urol., January, 1927, XVII, 53.

Radiographic examination after injection of oil.—The authors prefer radiographic examination after injection of an oily iodine solution to examination by Rubin's insufflation method. They have not noted subsequent secondary infection or salpingitis, as has been reported after that procedure. They state that before and after the iodine injections the patient should be observed in hospital. If there is obstruction at the uterine ostia of the fallopian tubes, the oil does not leave the uterus; if at the abdominal ostium, the ampulla still contains oil at the end of twenty-four hours. If the tube is permeable, little oil remains there, the bulk being found in the pelvic cavity. Radiographic examination after oily injections of iodine is a valuable preliminary to operations for dysmenorrhea or sterility, and in patients in whom salpingectomy or salpingostomy has previously been performed.

Radiological Examination of the Uterus (Sur l'exploration radiographique de l'uterus et des trompes apres injection de lipiodol). G. Cotte and P. Bertrand. La Gynecol., June, 1926, p. 353. (Reprinted by permission from Brit. Med. Jour., Oct. 30, 1926, p. 67 of Epitome of Current Medical Literature.)

Implants of Thorium X.—The author gives a continued report (see this Journal, 1926, VI, 216) regarding his experience with the implantation of small rods of Thorium X into malignant tumors. He uses unfiltered, gold and platinum implants. His results are not different from ours, following the application of radon seeds.

E. A. POHLE, M.D.

On Intratumoral Treatment. L. Halberstaedter. Strahlentherapie, 1926, XXIV, 253.